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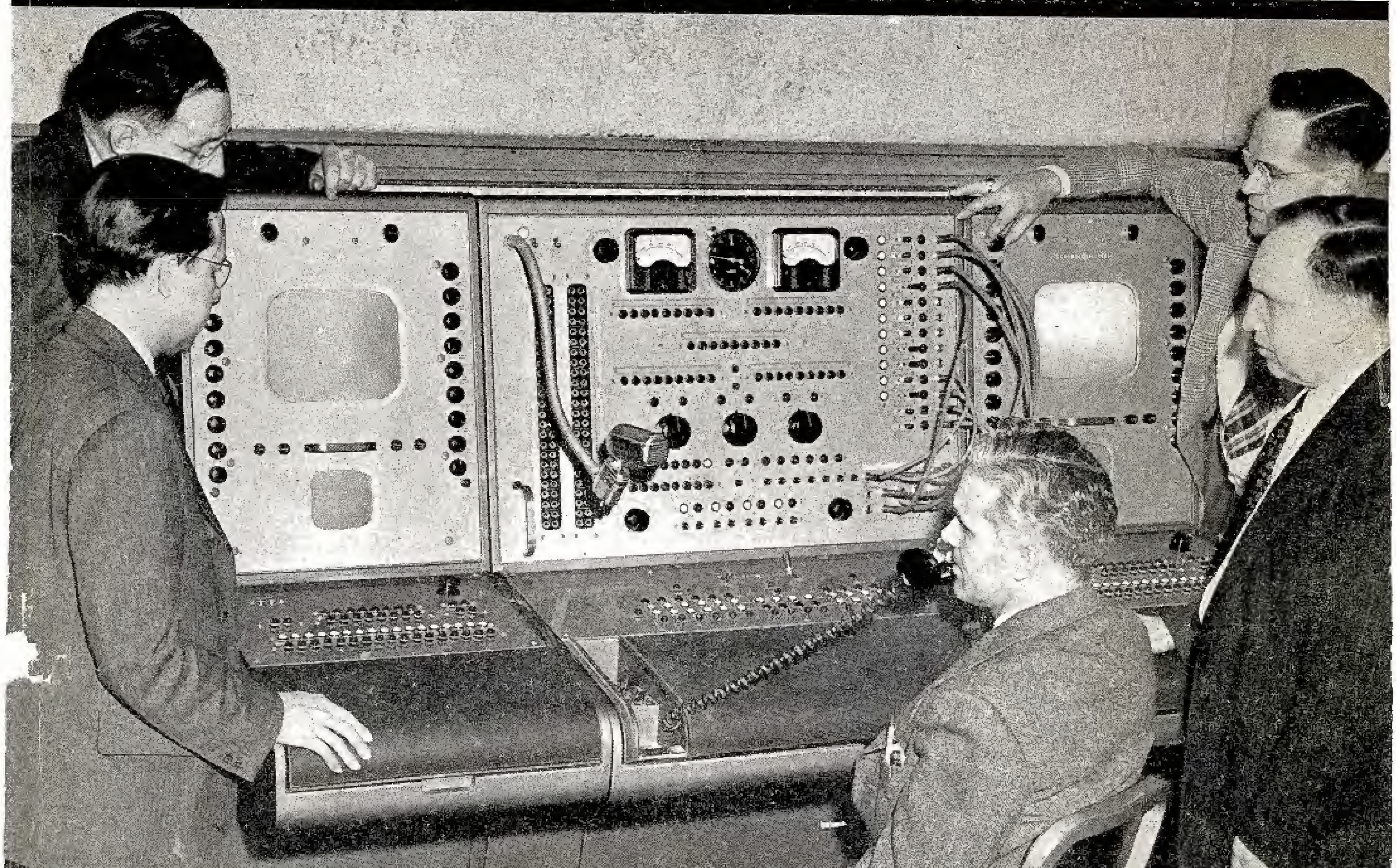


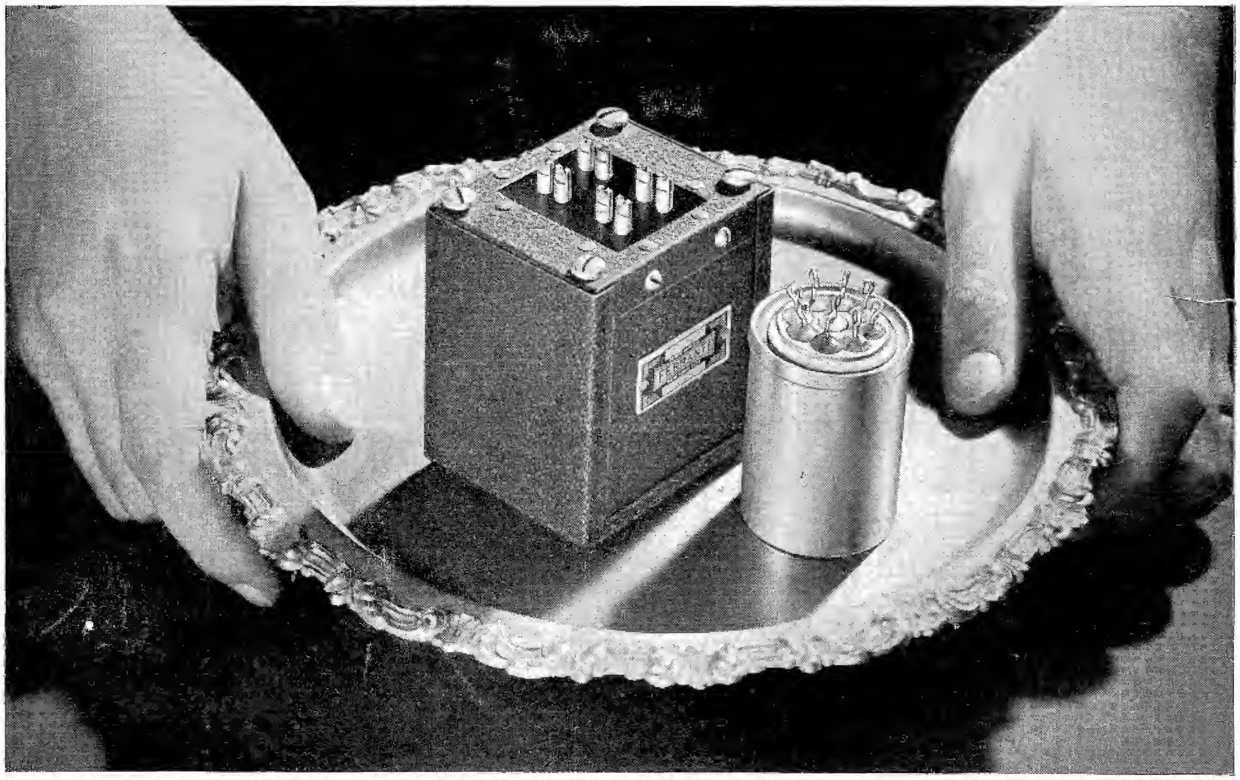
JUNE

★ TV ANTENNA DESIGN

★ A-M, F-M AND TV ANTENNA INSTALLATIONS

★ ANALYSIS PROCEDURES FOR BROADCAST STATION MAINTENANCE

1948



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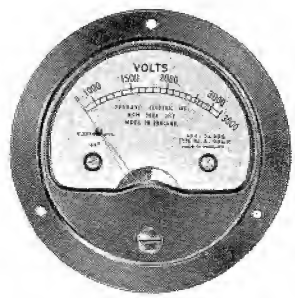

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JUNE, 1948 VOLUME 28 NUMBER 6

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COVER ILLUSTRATION

G.E. master tv console recently installed at WNAC-TV. At the console, left to right: I. B. Robinson (back); C. W. Stone; Thomas Foster at 'phone; Laird Whitledge and H. W. Whittemore (back) of the WNAC and WNAC-TV engineering departments.

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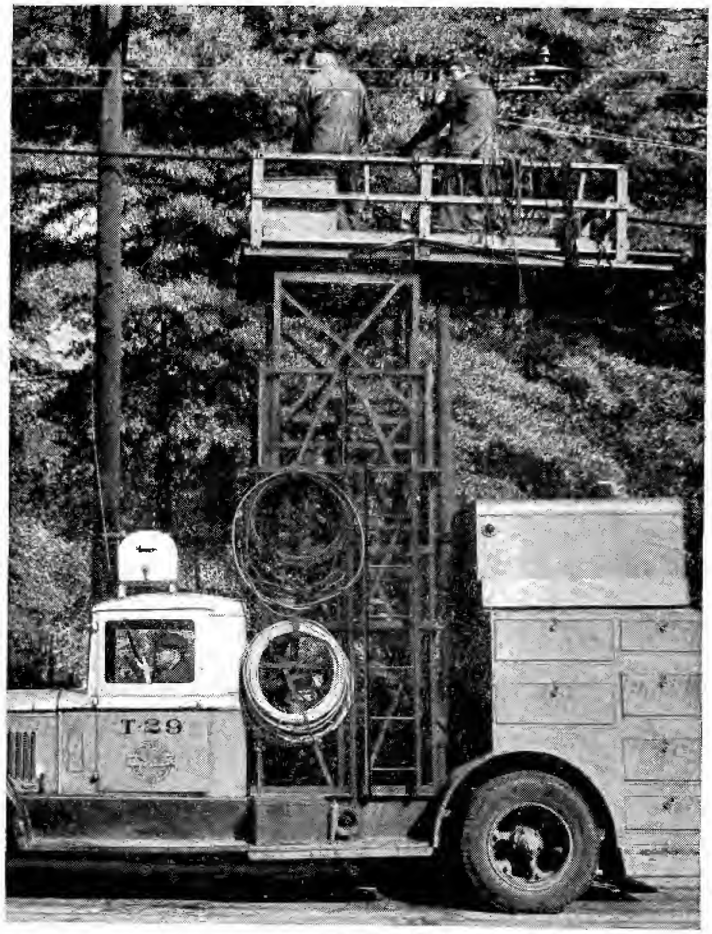

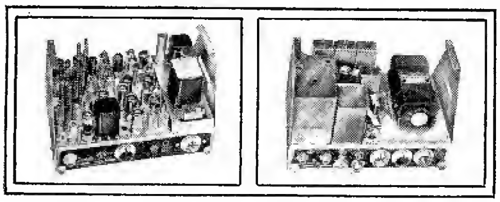

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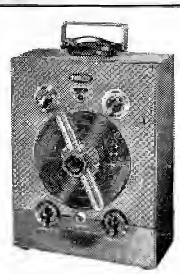

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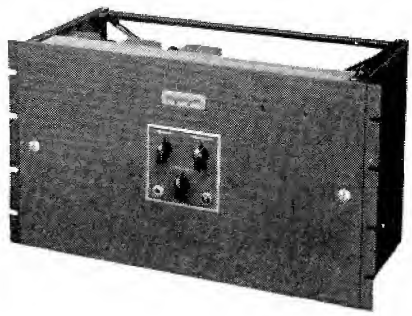

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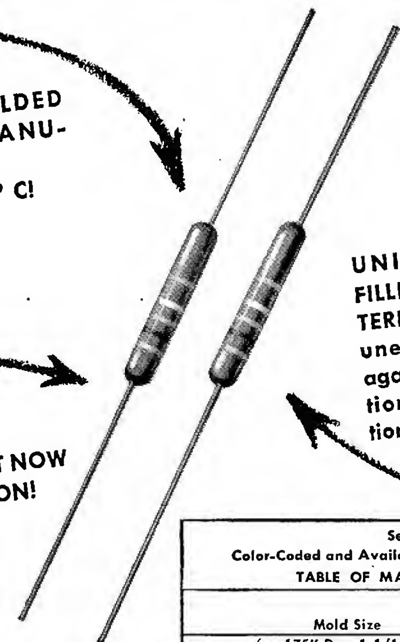

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	.195" D. x 1-1/16"	.022	.015	.01	.0033
	.250" D. x 1-1/16"	.047	.033	.022	.0068
	.375" D. x 1-1/16"	.15	.1	.068	——
75 P	.175" D. x ¾"	.0068	.0047	.0033	.001
	.200" D. x ¾"	.01	.0068	.0047	.0015
	.250" D. x ¾"	.022	.015	.01	.0033

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These new molded Prokars were designed specifically to satisfy stringent military requirements. Types 65P & 75P are now in mass production and are available in a wide range of capacities—from .00047 mfd. to .15 mfd! Though higher in price than standard units, they easily justify the term "premium" in performance. Rated for —50° C to 125° C operation, these small but rugged units are ideally suited for any electrical or electronic application in which size, temperature, humidity and physical stress are dominant considerations.

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PIONEERS OF ELECTRIC AND ELECTRONIC PROGRESS

COMMUNICATIONS

LEWIS WINNER, Editor

JUNE, 1948

Still Going Up

STATION CONSTRUCTION continues to race on. As of June 1, 350 had received CP's for a-m stations and 788 had received construction permits for f-m stations, while 118 had been granted conditional grants. The total authorization scoreboard for a-m and f-m stations now reads 2028 for a-m and 1035 for f-m. FCC reports that there are currently 543 f-m and 24 tv stations on the air. Incidentally, as of June, 95 had received tv construction permits, which adds up to a total of 102 authorizations for tv.

Field reports from FCC and industry indicate that we will see quite a jump in on-the-air operation and CP grants before the year is over, particularly in f-m and tv, with f-m possibly climbing to 2,000 authorizations and tv to at least 150.

Fax Goes Commercial

THE GREEN LIGHT for commercial facsimile has been turned on by the FCC and on July 15, eleven f-m stations now operating experimentally will go commercial.

According to FCC either the simplex or multiplex methods will be permitted. The simplex system interrupts the aural program during facsimile transmission, while in multiplex simultaneous transmission is effected. Accordingly, simplex transmissions will be limited to one hour between 7 A.M. and midnight, with no limit for the hours between midnight and 7 A.M., while multiplex transmission will be permitted for a maximum of three hours between 7 A.M. and midnight as well as any time between midnight and 7 A.M.

The recording width of 8.2" for 105 lines-per-inch scanning has been adopted a standard, although other paper widths will be permitted with the appropriate number of lines per inch.

Good luck to fax!

Directional Antenna Performance

IN DESIGNING A COMPLETE BROADCAST station installation, the directional antenna system must receive priority attention and many factors judged. Since the field gain of a directional array is a function of the tower spacing, field ratios and field phases, we have a number of variables to consider such as types of arrays, constants of transmission lines, coupling equipment, ground system, guying, etc.

An excellent interpretation of this problem was presented at the recent NAB Conference at Los Angeles, by A. Earl Cullum, Jr. Discussing guy wires, he showed how they can seriously affect the pattern shape. This effect can be minimized by installing the guys so that they are symmetrical with respect to the line of towers and by breaking them up with insulators near the tower and near the ground as well as throughout their length. It is also necessary, he said, that the tower section be bonded at all legs so that the current in the tower is equally distributed. Cullum pointed out that even the ladders must receive careful attention, requiring sectionalizing so as to carry a minimum of current or secure bonding so as to carry a proportional amount of the tower current.

Analyzing the features of current and phase-monitor antenna systems Cullum said that this type of system provides a reliable indication of the magnitude and phase relationship of the fields radiated by the elements of a directional array. Describing the location of a sampling loop with this equipment, he pointed out that excellent results have been attained by locating the loop in one leg of a tower so as to sample the current at that point, although in a wide base tower, each leg can and does act independently. A loop which samples a single leg of a well-bonded thin tower often provides the best indication. To be sure that the sample current is accurately indicated by the monitor, Cullum said that all sampling lines from the loops through the isolation coils and to the monitor, must be identical as to length and characteristic impedance, must be properly terminated at the monitor and should be maintained near the same temperature throughout the system.

S-T F-M U-H-F Relays

WITH F-M ANTENNA SYSTEMS being located in remote high-altitude areas, the need for u-h-f high-fidelity studio-to-transmitter links has grown, prompting intensive activity in the development and production of suitable equipment. As a result of one s-t-l research program, a 10-watt transmitter featuring a radial cavity in the plate output circuit, operating on the fundamental mode, has been developed. Describing this transmitter at the recent NAB Engineering Meeting, D. J. Nigg and W. G. Broughton of G. E. pointed out that the system uses ± 75 kc deviation for 100% modulation and direct f-m. The last three stages in the transmitter employ 4X150A tetrodes as frequency doublers. Open transmission line circuits are used for these doublers except for the plate circuit of the output stage.

Antennas are of the 40" parabolic-reflector type, with dipole feed. Receiver is a double conversion superhet. Frequency range of transmitter and receiver are in the s-t-l band of 920 to 960 mc.

U-H-F TV

WITH TV ALLOCATION REQUESTS pouring into Washington, and the need for additional channels imminent, the channels upstairs in the 475 to 890-mc bands are receiving quite a probing. Out in San Francisco, former FCC chief engineer, George P. Adair, now a consultant, put a 600-mc 700-watt tv setup on the air recently (W6XJD) to explore propagation characteristics at these frequencies.

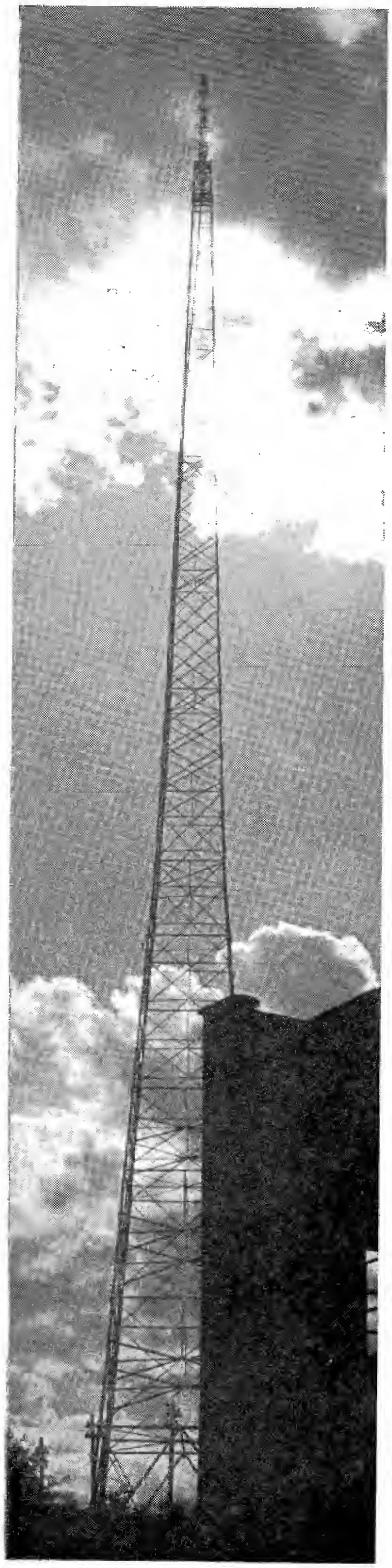
In Washington, a 510-mc 25-kw station will be installed in the Wardman Park Hotel by RCA to study u-h-f tv. The transmissions of WNBW on 67 mc will be duplicated on the 510-mc transmitter during these tests.

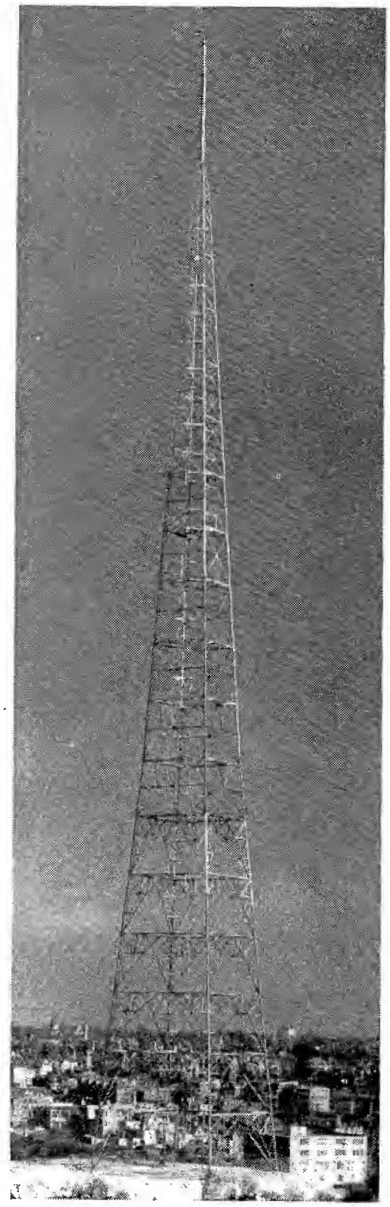
To conduct field test comparisons, observers will use converters on standard tv receivers for u-h-f pickup.

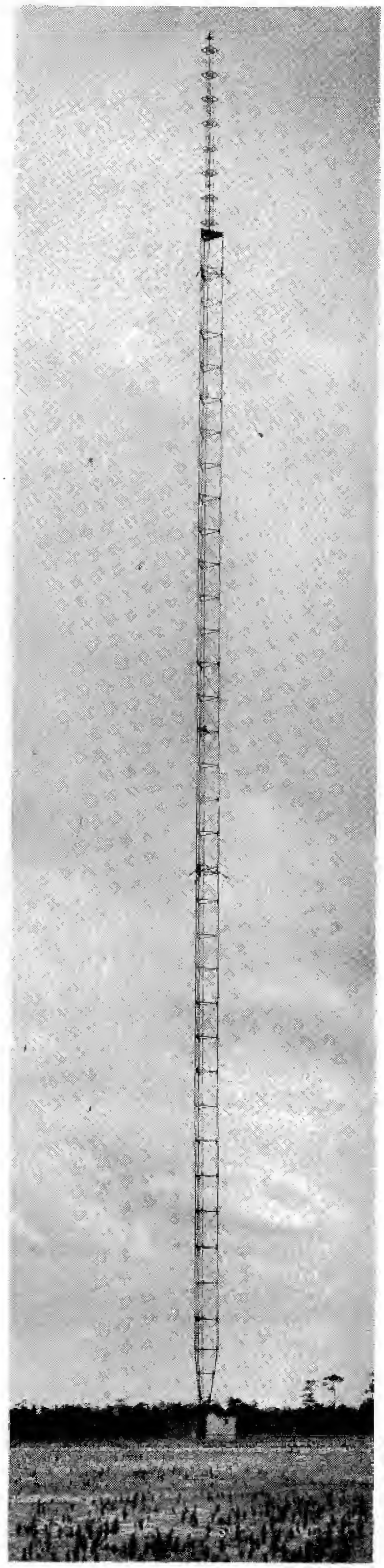
Results of these and other tests will be detailed at the FCC hearings in Washington on September 20.

A complete report on these sessions will appear in COMMUNICATIONS. Watch for it.—L. W.

A-M, F-M And TV

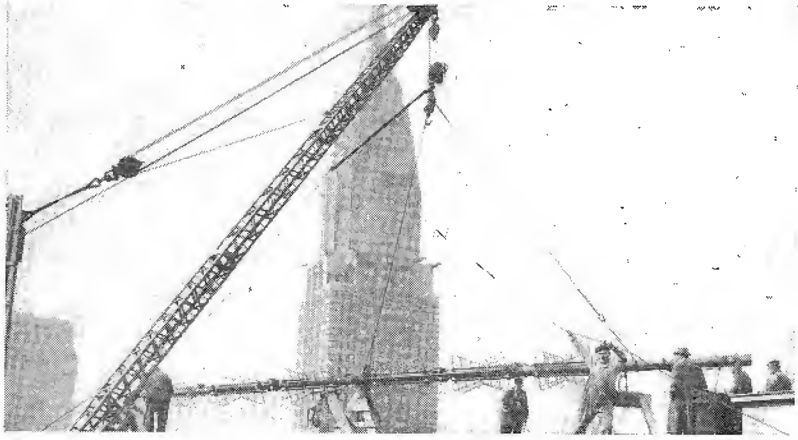




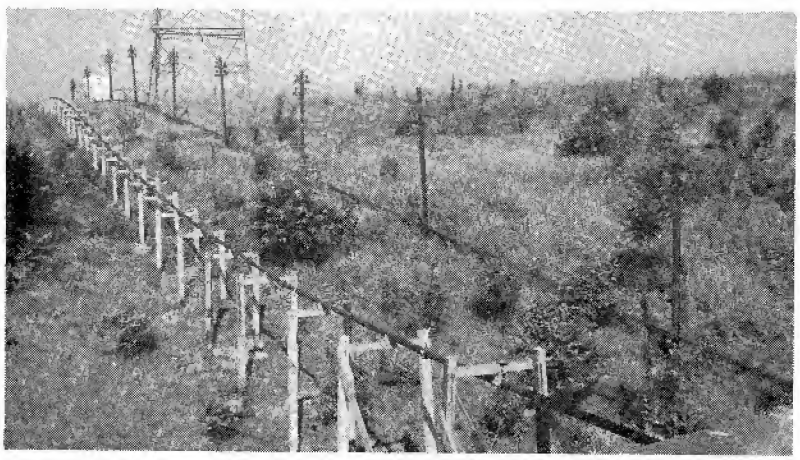


Left: Modified a-m Blaw-Knox tower supporting a 4-bay W.E. clover leaf f-m antenna at WSTV, Steubenville, Ohio, providing simultaneous a-m and f-m broadcasts. (*Courtesy Westinghouse*). Top: A four section RCA pylon f-m antenna atop a Blaw-Knox tower at WCTS, Cincinnati, Ohio. Right: The f-m antenna of WHOO, Orlando, Fla., with an 8-bay FTR square loop antenna mounted atop a 414′ Truscon guyed pipe tower.

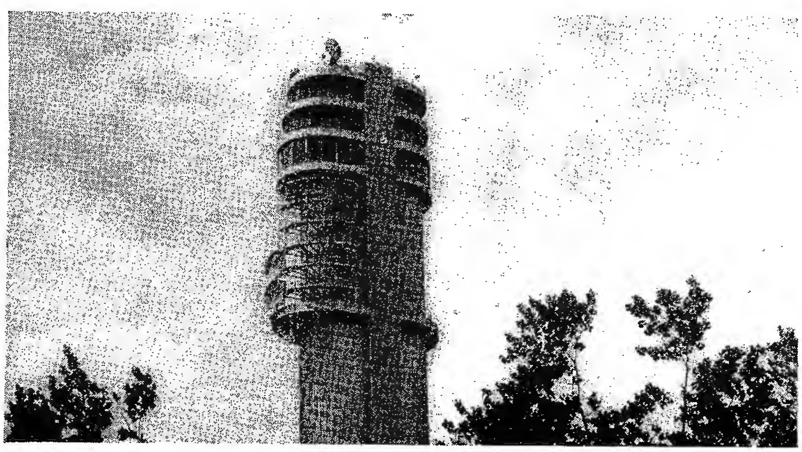
Antenna Installations

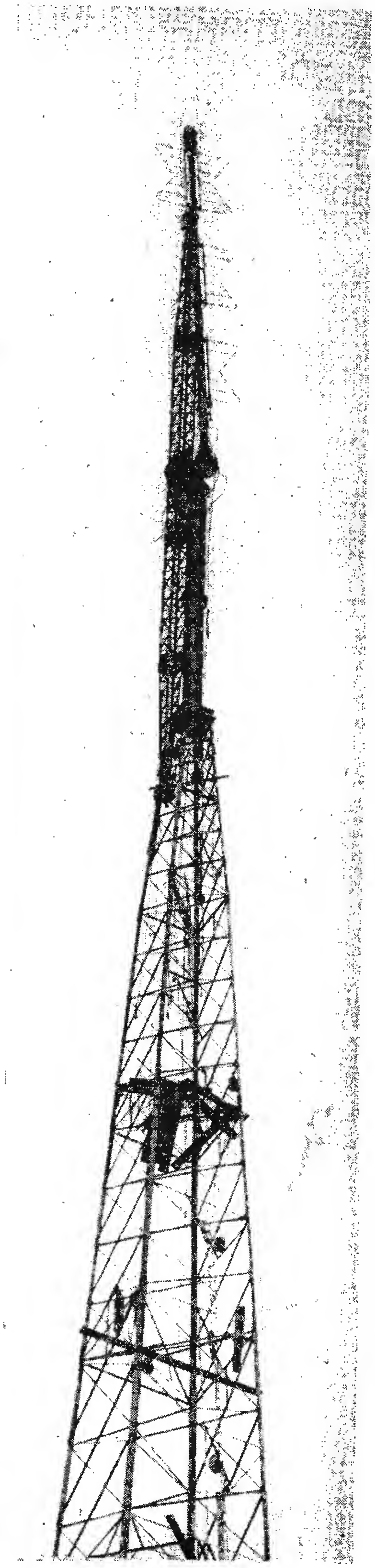


Top: Six-bay RCA super turnstile antenna being hoisted to the roof of the 36-story News Building in New York City for WPIX, the *Daily News* tv station which went on the air on June 15 on channel 11. Below: Coaxial transmission line ($3\frac{1}{8}''$ Andrew type) at WSTV, Steubenville.



Below: View of the 300′ microwave tower recently completed for the Federal Telecommunication Laboratories at Nutley, N. J. The tower houses experimental antennas and equipment for research and development work in television, aviation communications, multiplexing, microwave antennas, point-to-point communications, etc. Right: Three-bay RCA super turnstile tv antenna being mounted atop an RCA pylon f-m antenna for WBZ-TV near Harvard Stadium, Mass. Tower is 656′ high and designed to service an area of 40 miles radius of Boston.





Wide-Range Dual-Band TV Antenna Design

Versatile, Sturdy Antenna Designed to Cover the 54 to 88 and 174 to 216-MC TV Bands, Provides a Substantially Uniform Directivity Pattern and Constant Input Impedance. Can Be Operated in Conjunction with Either Balanced (Twin Lead) or Coaxial Transmission Lines. Antenna Can Be Grounded for Lightning Protection.

by LESTER L. LIBBY

Chief Engineer
Ohmega Laboratories, Inc.

THE DIPOLE ANTENNA in one form or another is perhaps the most commonly employed type of antenna for operation in the v-h-f range. The half-wave mode of operation of the dipole is frequently used as a standard of reference for describing the gain of an antenna array or system, and the impedance and directivity characteristics of the half-wave dipole have been evaluated and discussed in many papers[1] and books.[2]

In general, the values of feed-point resistance and reactance of a dipole antenna versus frequency will be a function of the geometric shape of its conductors. For cylindrical conductors of length l and diameter d, such as shown in the antenna of Figure 2, Schelkunoff[1] ascribes an average characteristic impedance parameter, K_a, given by the expression

$$K_a = 276 \log_{10} \frac{2l}{d} - 120 \qquad (1)$$

and also shows families of curves relating the resistance and reactance of such antennas to their *electrical length* for various values of K_a ranging from 500 to 1,200.

From a practical consideration of strength, weight and cost of a tv receiving antenna it becomes evident that a conductor diameter of the order of ½″ is a very desirable size, and a dipole length cut to be resonant at 65 mc (the approximate center frequency of the lower television band) is the best compromise for good overall response and service in this range. The dipole length for half-wave resonance at 65 mc is very closely 7′, so that the resultant K_a is approximately 600 for a conductor diameter of ½″.

The curves of feed-point resistance and reactance of this dipole versus frequency are accordingly those shown in Figure 3, and labeled R and X, respectively. The complex feed-point impedance at any frequency is $R + jX$, taking due note of the sign of X as given in the curve of Figure 3. Hence at 65 mc the antenna impedance is $58 + j0$ ohms. At 55 mc, the antenna impedance is $38 - j120$ ohms and at 80 mc, the antenna impedance is $113 + j140$ ohms, etc. It is evident from examination of the curves that, although the resistive component of the antenna impedance varies appreciably with frequency, the reactive component in the region of half-wave resonance varies much more rapidly, hence making it difficult to match the antenna to a transmission line within more than a narrow band of frequencies immediately surrounding the resonance frequency.

Broad-Banding the Dipole

Let us consider now the possible methods whereby the useful range of operable frequencies, i.e., the bandwidth, of the foregoing antenna may be increased. One expedient which suggests itself is to connect in series with the antenna and its transmission line a reactance of equal magnitude and opposite sign to that which the antenna exhibits at all frequencies. This would then result in an antenna whose impedance was purely resistive at all frequencies and equal in value to the R curve shown in Figure 3. If this hypothetical antenna were operated with a 73-ohm transmission line, it would match this line to a reflection factor of less than 0.5 (corresponding to a voltage standing-wave ratio of less than 3:1) between the frequency limits of 45 and 90 mc. However, a series-compensating reactance having the complementary characteristics described is not readily realizable nor available, so that such a completely compensated antenna remains purely hypothetical. It is possible, however, to obtain partial reactive compensation of the antenna by means of a shunt reactance of proper magnitude and opposite sign to that of the antenna reactance. Such a reactance is realizable by shunting a shorted parallel-wire transmission line stub, of effective electrical length equal to a quarter-wave at a frequency slightly above the resonant frequency of the antenna, across the antenna feed-point terminals, and choosing the characteristic impedance of this transmission line stub to be in the range from 50 to 100 ohms. Figure 4 illustrates an antenna system of this type while the dotted curve of Figure 3 shows the reactance characteristic of the shorted stub for a Z_o of 50 ohms, and a stub resonant frequency of 70 mc. It is apparent from examination of Figure 3 that the stub reactance tends to *tune out* the antenna reactance in the neighborhoods of 54 and 82 mc. At the same time, the high impedance of the

[1]For example, S. A. Schelkunoff, *Theory of Antennas of Arbitrary Size and Shape*, Proc. I.R.E.; September, 1941.
[2]For example, N. Marchand, *Ultrahigh Frequency Transmission & Radiation;* John Wiley & Sons, Inc., New York, N. Y.; 1947.

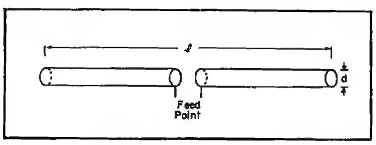
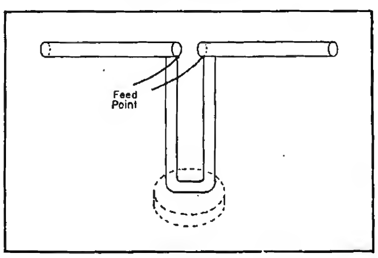


Figure 2
Dipole antenna with cylindrical conductors.

Figure 4
Cylindrical dipole with a compensating stub for broad-banding.



stub in the 65-mc region (where the antenna reactance component is low) results in negligible shunting effect on the antenna, so that the antenna system now has *three* frequency regions where the reactive component is small instead of the *one* frequency region possessed by the simple dipole. This results in effective broadbanding of the dipole within the frequency range of about 50 to 85 mc, thus making this antenna system quite well-suited for tv use in the complete low-frequency band.

A feature of this type of antenna system is that the combined dipole and stub conductor assembly may be fabricated from a single piece of metal rod or tubing, thus eliminating joints which might otherwise be subject to trouble from corrosion, structural weakness and the like. In addition, it is possible to attach a metallic base flange to the stub as shown in Figure 4, the flange serving the two-fold purpose of acting as a mounting base for the antenna as well as improving the nature of the electrical *short* on the end of the transmission-line stub. Under these conditions the stub itself serves as a very effective mounting support for the dipole, and the need for strong dielectric-type supporting insulators for the antenna is eliminated. The base flange may be mounted to any type of surface whatsoever without impairing the impedance properties of the antenna system.

Dual-Band Arrangement

For operation in the upper television band, the 65-mc antenna system begins to exhibit unfavorable characteristics with regard to both impedance and directivity pattern. As an example, the resistive component of antenna impedance at 195 mc (where the dipole goes through its 3/2 wave resonance mode), is of the order of 125 ohms, and the directivity pattern breaks up from its 65 mc *figure-of-eight* shape into a *six-leaf clover* shape. This is depicted in Figure 5, where is shown one-half of the normally symmetrical pattern. The *clover* pattern is generally undesirable for tv reception since it has null response points in directions other than off the ends of the dipole.

To overcome the deficiencies of the single dipole a dual-band antenna system* has been devised (Figures 1 and 6). In this antenna system a second dipole antenna unit, resonant at 195 mc (i.e., at exactly three times the frequency of the 65-mc dipole unit), has been attached to the broad-banding stub at a distance one-third of the way up from the bottom of the stub (or two-thirds of the way down the stub from the feed point). The presence of this 195-mc dipole unit has a substantially negligible effect on the operation of the antenna system in the 65-mc region, since it represents but a small shunt capacitive discontinuity 30° up from the shorted end of the stub at this frequency. However, at 195 mc, the small dipole is now a quarter wavelength up from the shorted end of the stub and a half wavelength down from the top or *feed-point* end of the stub. Accordingly, the lower one-third of the stub now acts as a *broad-banding* reactance for the 195-mc dipole, while the upper two-thirds of the stub acts as a half-wave length of transmission line which serves to connect the broad-banded 195-mc dipole assembly directly across the feed-point terminals, putting it in parallel with the 65-mc dipole in the upper television band. Now, since

*Megatenna.

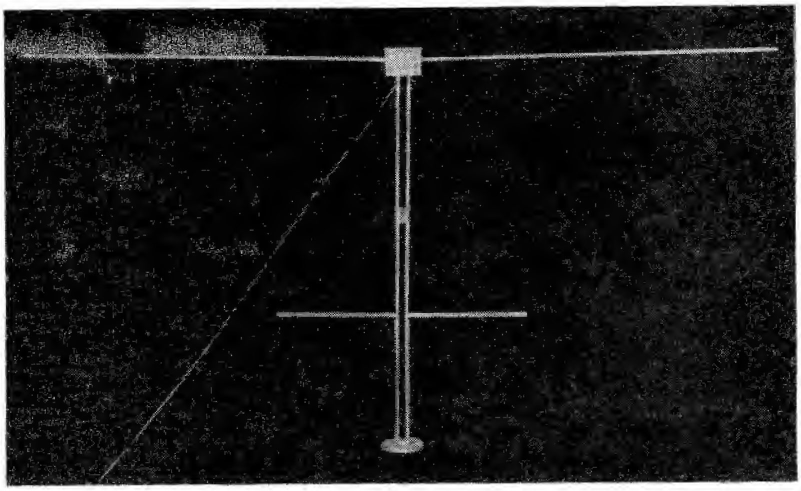


Figure 1
Experimental model of the dual-band antenna system.

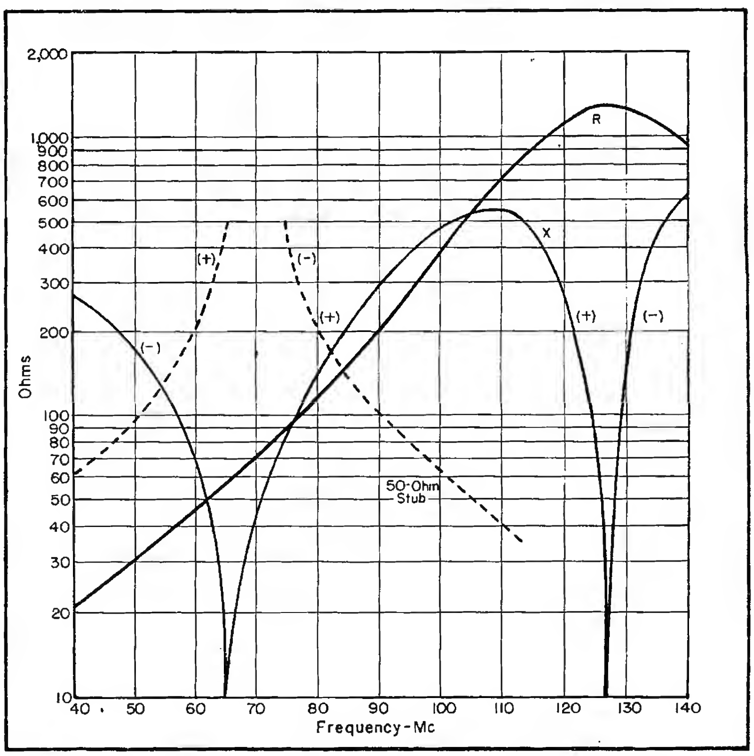


Figure 3
Plot of resistance and reactance versus frequency of a 65-mc dipole section of the dual-band antenna system.

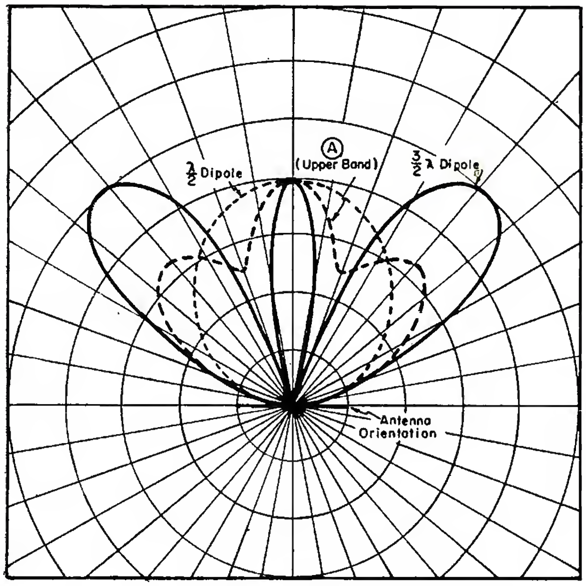


Figure 5
Antenna directivity patterns (two quadrants); plot at *A* is for the dual-band antenna.

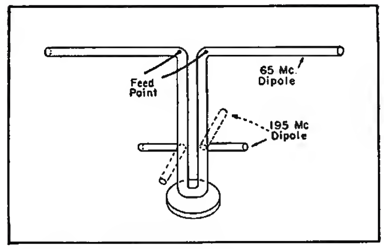


Figure 6 (Above)
Makeup of the dual-band antenna system, illustrating two possible orientations of the high-band dipole with respect to the low-band dipole.

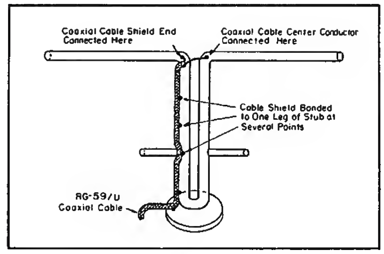


Figure 7
A coaxial feed arrangement for the dual-band antenna. The outer insulating jacket of coaxial cable is removed for length of stub.

the resistance of the large dipole is about 125 ohms at 195 mc, while the resistance of the small dipole is about 60 or 70 ohms, the small dipole tends to *take over* in this frequency region and contribute the major amount of the received energy to the transmission line system connecting the antenna to the tv receiver. Because the small dipole contributes the greater amount to the total received energy of the antenna system, its *figure-of-eight* directivity pattern will predominate over the *clover* pattern of the large dipole, and the resultant directivity pattern will be a composite shape of the form shown in Figure 4 by the long-dashed line. Since this resultant upper band directivity pattern now has no sharp null responses other than those off the ends of the dipole, it is hence well suited for regular tv use.

Coaxial Cable Feeder Arrangement

Up to this point the transmission line feeder for the antenna has been depicted and discussed on the basis of a *balanced* line. However, the dual-band antenna can be used with equal effectiveness in conjunction with coaxial type transmission line, since it contains within its structure the elements of a balanced-to-unbalanced transformation device. Thus, referring to Figure 7, the coaxial cable is positioned against one leg of the broad-

(*Continued on page* 30)

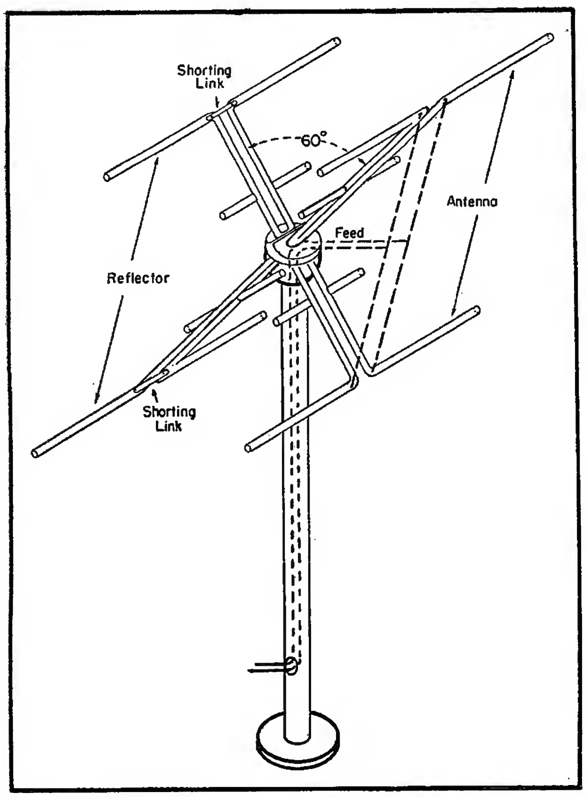


Figure 8 (Below)
Method of mounting two-dual-band antenna assemblies to obtain a dual-band antenna-plus-reflector system.

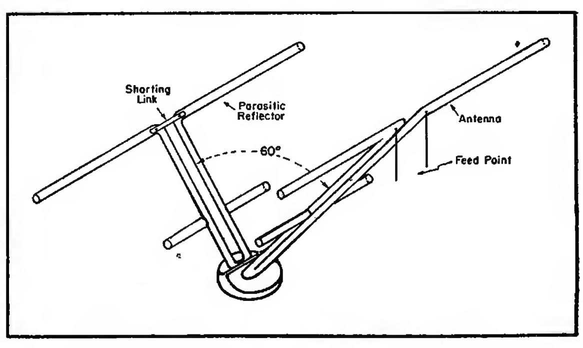


Figure 9 (Left)
An *X* type of array using four dual-band assemblies.

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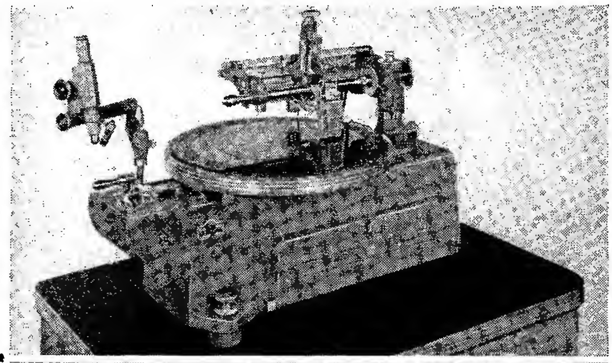
Presto 8D-G Recorder

Extreme accuracy . . . designed for the finest instantaneous and master recordings. A special feature is the direct gear drive with separate motors for 33⅓ and for 78.26 rpm. Overhead driven independently of the turntable and has a choice of seven different feed pitches in each direction.



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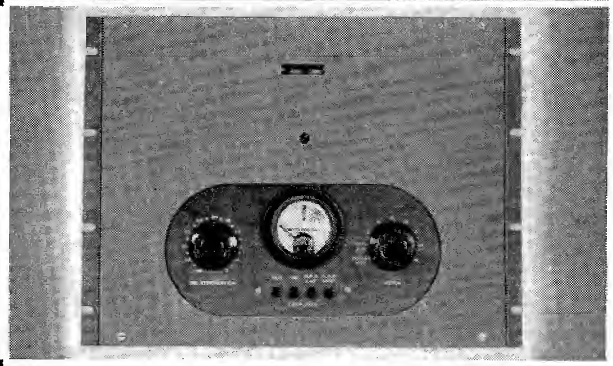
Presto 92-A Recording Amplifier

Sixty-watt amplifier especially designed for high-fidelity recording. Vertically mounted chassis. Removal of front panel gives access to all circuits. Output stage has four 807's in push-pull parallel. Selector switch and meter provide both output level indicator and plate current readings for all tubes. Response: 20-17,000 cps.



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Presto 64-A Transcription Unit

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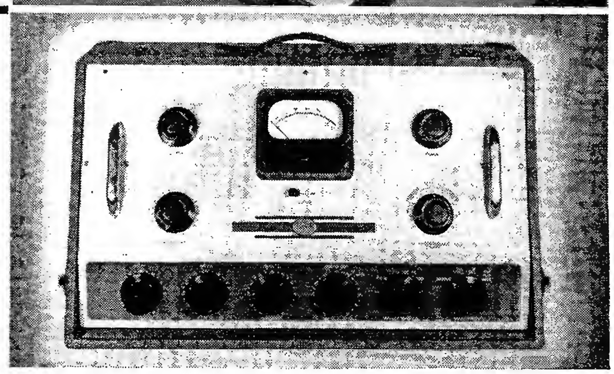

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Equipment Failure-Control System For Broadcast Stations

Inspection, Maintenance and Trouble Data-Recording Procedure, Which Reveals Types of Failures to Be Expected, The Relative Rates of Occurrence and Effectiveness of Repair Work.

by F. E. BUTTERFIELD

Engineering Department
The Andrew Company

THE APPLICATION OF analytical systems has streamlined maintenance procedures, providing an effective balance of control expense and results.

A three-point procedure has been found very productive:

(*1*) *Inspection*: Equipment test procedure, with standards of performance, applied periodically to locate the maximum number of faults before they render equipment inoperative.

(*2*) *Maintenance*: Equipment maintenance procedure, applied when equipment fails in service or fails inspection, and having its own set of performance standards; developed to keep equipment in operation for the longest possible periods.

(*3*) *Analysis*: Trouble-analysis procedure which presents data for evaluating (*1*) and (*2*), for estimating the efficiencies of personnel and training and for finding costs associated with particular maintenance operations.

Since the analysis of faults has to be based on the statistics of failures in service, accurate analysis can be obtained only with large groups of identically constructed and operated equipment, say fifty units or more. This is not true about test and maintenance procedures. The tests which are most suitable for large scale operations may be of great help in determining the condition of some isolated unit. However, effective test procedures can be determined only by actual trial and analysis on large numbers of units.

Test and maintenance procedures, recommended and published by technical societies and manufacturers and prepared after considerable trial and analysis are general in nature and not necessarily adapted to particular operations. They do not ordinarily form completely satisfactory procedures without a good deal of addition in some details, elimination in others.

Inspection Procedures

An inspection procedure, ideal for the purpose of preventing failures of equipment in service, would be simple, easy and quick to complete, and would determine the point and time at which the unit would fail if continued in operation. Unfortunately, the most that an inspection actually can indicate is the effectiveness of a unit at the moment the test is applied. In the cases of some units, mainly mechanical in nature, this information, gathered at regular intervals can be related to the life of the units and will then show the remaining service which can be expected from them. The performance of most electrical components is such, however, that failures are erratic and relatively unpredictable. Thus for the electrical unit, the inspection will answer the question "What will this unit do now?"; if that answer is not good enough, the unit must be repaired.

Typical Inspection Procedure

In one test procedure applied once a month to a large group of communi-

(*Continued on page* 34)

EQUIPMENT REPAIR RECORD

EQUIPMENT TYPE ____, NO. ____

DATE	WORK DONE	BY

Figure 2
Equipment repair record card.

Time Reported	Equipment Type and Number	Failure Reported	Action Taken	Trouble Found	Time Repaired	Repairs Made	Repaired By

Figure 1 (Above)
Form which can be used to record failures in service.

Figure 3 (Below)
Inspection report.

Date	Equipment & Number	Inspection Procedure	Failure	Inspected By	Repairs Made	Time Required	Repaired By	Date
1	2	3	4	5	6	7	8	9

Figure 4
Equipment failure analysis sheet; summarization of data on *1*, *2* and *3* forms.

JAN.	FEB.	MARCH	APRIL	MAY

1 EQUIPMENT TYPE
2 PERIOD
3 NUMBER OF UNITS IN SERVICE
4 FAILURES IN SERVICE
5 (BREAKDOWN)
6 SERVICE INTERRUPTION (UNIT HRS.)
7 REPAIR TIME (MAN HRS.)
8 FAILURES IN SERVICE/UNIT
9 SERVICE INTERRUPTION/UNIT
10 INSPECTION REJECTIONS
11 (BREAKDOWN)
12 INSP. AND MAINT. TIME (NOT INCLUDING TIME IN LINE 7)
13 INSPECT. REJECTIONS/UNIT
14 FAILURES IN SERVICE/INSP. AND MAINT. TIME
15 TOTAL FAILURES/INSP. AND MAINT. TIME
16 TOTAL TIME SPENT (MAN HRS)

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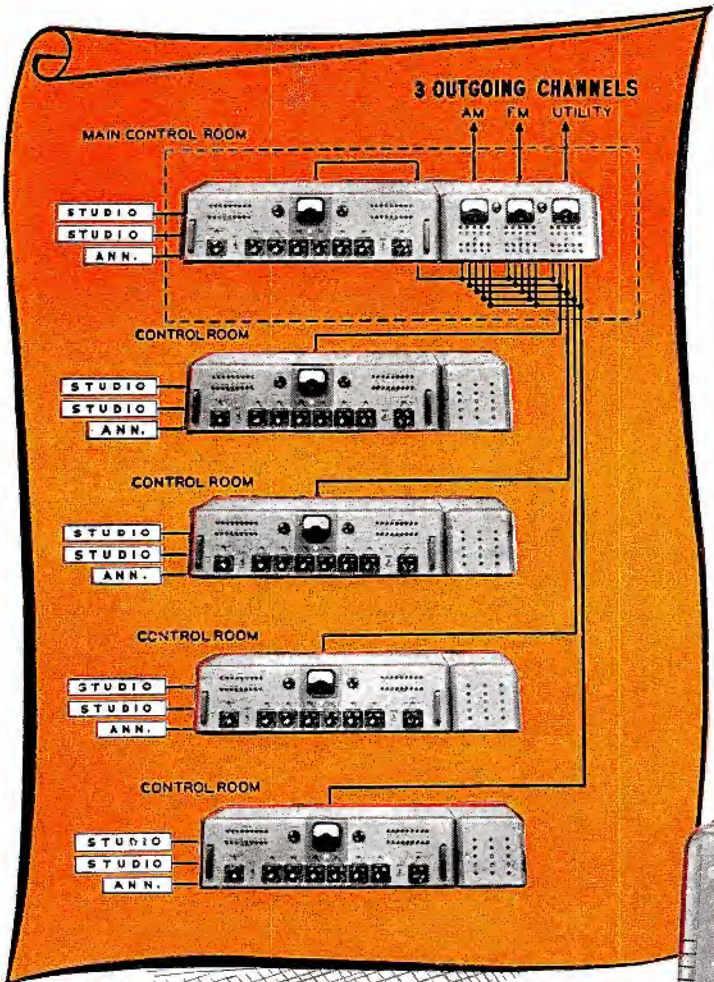
Simple switching for your

RCA 76-B5 Consolette

Type BCS-1A Master Switching Unit



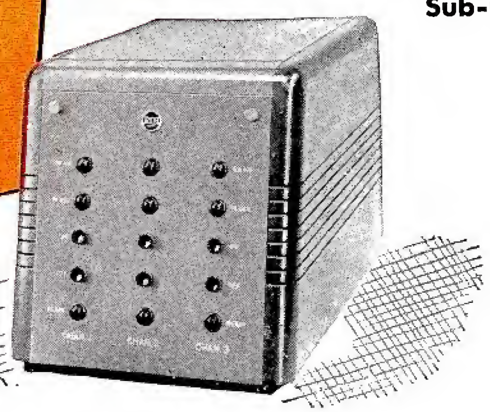
Type BCS-1A Master Switching System

This system consists of one Master Switching Console (above, right—shown with an RCA 76-B5 Consolette), and one or more sub-control units (below). It contains all the relays needed for any combination of switching functions.

Up to five sub-control rooms can be used with the master console, each of which can handle from one to three studios.

Status lights give accurate picture of "On Air," "In Use," "Ready," and "On-Off" conditions in all control rooms for each outgoing line. Unique design features prevent feeding more than one program to any one line, although supporting program material can be handled as remotes from the originating studio. Sub-control units act as relay control stations between studios and master control unit.

Type BCS-1A Studio Sub-Control



AM-FM Programming

RCA consolette switching systems co-ordinate all studio-station functions

• Here's another example of RCA's program of providing "packaged" broadcast equipments having the flexibility and performance of custom-built jobs.

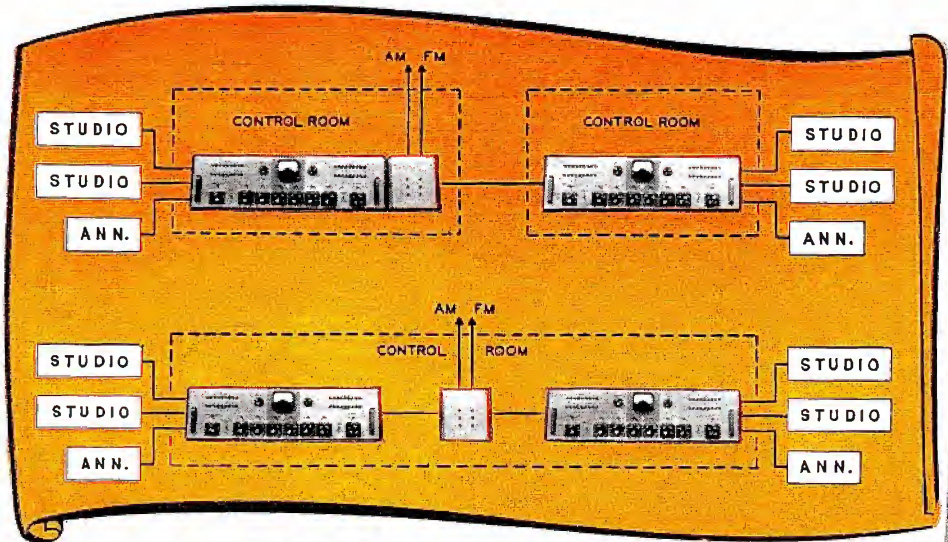
The two Switching Consoles shown, in connection with standard RCA Consolettes of identical styling, give you sufficient latitude to perform intricate AM, FM and network programming operations—easily, precisely and quickly. Choice of model depends upon the complexity of your station's operating requirements.

The BCS-1A Console is designed for the more elaborate station . . . switching the outputs of as many as five control consolettes to three outgoing lines. Many combinations are practicable. Inputs from studios, network, recording rooms or frequent remotes can be monitored and switched to transmitters or network lines. Electrically interlocking controls have reduced the possibility of switching error to the vanishing point.

Managers of stations requiring only two consolettes will find the RCA Type BCS-2A Console the ideal switching system. Used with two RCA 76-B5 Consolettes, program material from as many as four studios and two announce booths is routed to desired outgoing lines (AM and FM, or either transmitter and a network line).

• • •

Both types of RCA Switching Systems are designed for long-range station planning. They have sufficient flexibility to take care of future expansion. Complete details may be obtained from Engineering Products Dept., Section 23-F, Radio Corporation of America, Camden, N. J.



Type BCS-2A Switching System

Two studio inputs may be switched independently to either of two outgoing lines. Mechanical interlocking prevents feeding two inputs to the same line. This system handles up to four studios and two announce booths. Two examples of the layouts possible are shown above.

Studio Switching Console for Small Studios

BROADCAST EQUIPMENT

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

TV Transmitter Design

In the initial installment[1] of this series appeared a discussion of the general design problems encountered in tv transmitter systems, with special consideration of the exciter and video modulator units, and d-c restorers.

In the analysis of d-c restorers, a series of wave forms were presented, the concluding figure showing various wave shapes and the manner in which equal areas are established about the zero a-c reference axis.

Continuing with our d-c restorer study, we find that if the time constant is sufficiently large, a voltage will be generated across the diode load resistor about equal to the peak value above or below the axis dependent upon the polarity of diode connection. Figure 1 shows a simplified circuit breakdown of a typical video amplifier, d-c restorer and modulator.

The restorer operates in a manner such that an additional biasing potential is applied to the modulator; in this case opposite to that supplied by the bias supply. For the wave shapes shown last month in Figure 9, the bias differential will be equal to the peaks appearing below the average a-c axis. This is shown graphically in Figure 2, assuming an adequate time constant.

From Figure 2, it will be noted that the effect of the d-c restorer is to refer the peak of the applied signal to the quiescent bias level. In the case of (*d*) and (*e*), the sync tips are held at the reference level of the quiescent bias and any signal excursion toward *white level* results in a reduced grid voltage, with a consequent increase in plate current. This produces a signal voltage across the plate load resistor, and since this point is conductively coupled to the grids of the modulated amplifier, produces negative modulation from the condition of no video signal. In effect, this states that a white picture drives the modulated amplifier toward cutoff or minimizes output, while a black picture drives the amplifier toward maximum output. Figure 3 shows a typical transfer characteristic for the two conditions outlined.

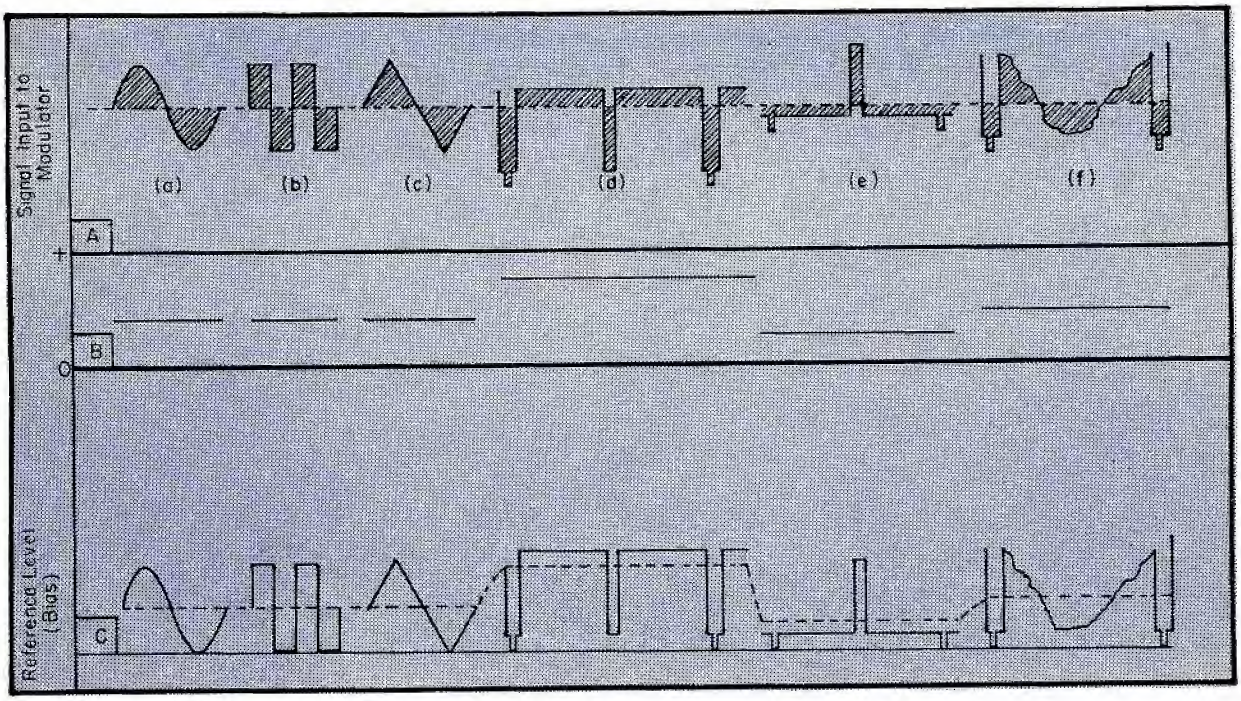
Modulated Amplifier Considerations

Three conditions for one setting of r-f drive are shown in Figure 4: (*1*) no video modulation, (*2*) white picture modulation, and (*3*) black picture modulation. For proper operation of a grid-modulated amplifier, the parameters should be adjusted to provide the results illustrated. Obviously, a balance between r-f drive, video signal amplitude, and bias is essential.

Fundamentally, a television grid-bias-modulated stage operates under conditions similar to class *B*, i.e., the tubes are biased in the vicinity of cutoff. In Figure 4, we find the ideal case where the bias is adjusted so that signal excursions about this point maintain the output waveform over a linear portion of the grid plate transfer characteristic. Should the bias be excessive, operation will be about the lower knee of the transfer curve and the resulting non-linearity will cause compression in the signal representing the white picture area. This condition is most easily noticed as amplitude distortion of a linear gray scale. When the bias is not as great as the tube linearity allows, full advantage of the grid base is not realized, and sync compression may take place. Sync compression is the result of operating on the upper knee of the transfer characteristic, and is evidenced by changing the ratio of sync to video-plus-sync;

[1] May, 1948, Communications.

Figure 2
At *A* (top), graphical representation of various wave forms about the *zero* axis. *B* (center) shows the d-c restored voltages for the wave forms above. At *C* (bottom), the signal is shown referred to the fixed bias potential; it consists of the summation of the bias, the restoration voltage and the signal input. Note how the a-c axis shifts by action of the d-c restorer.



Modulated Amplifier Considerations . . . Adjustment of Video Signal Amplitude . . . Equipment Used for Adjustment of Class B Linear Amplifiers.

by G. EDWARD HAMILTON

Head, Television R-F Development Section
Television Transmitter Department
Allen B. Du Mont Laboratories, Inc.

instead of being 25% it may decrease to a value of 20% for example.

The r-f drive (without video signal) must be sufficient to drive the plate current up to the upper knee of the transfer characteristic; above this level the plate current is no longer a linear function of grid excitation. With modulation, the sync plate current tips extend upward and any excursion into the upper knee will result in limiting or sync compression.

Adjustment of video signal amplitude is also of prime importance since upon this factor depends the modulation percentage levels for tv picture information, i.e., the FCC has decreed that the synchronizing impulses must occupy 25% of the total r-f signal amplitude, and that the transmitter be modulated down to at least 15% of the peak level on white picture detail. These limits are shown in Figure 5 for a black picture with a white line, with respect to relative r-f signal amplitude. To operate within these prescribed limits, which permit an effective modulation capability of only 85%, it is necessary to drive the transmitter with an augmented sync to picture ratio. Analysis of the proportions of Figure 5 shows that the input video signal must consist of 29.5% sync, referred to the peak-to-peak value of the input video signal (100%), the video comprising the remaining 70.5%. There are numerous methods of adjusting the three factors for satisfactory initial operation. One found to be practical (assuming correct bandwidth, amplitude response, modulation capability, etc.) is:

(1) With *no* video signal and *no* r-f drive, the modulated amplifier bias is adjusted to *almost* plate current cutoff.

(2) The r-f drive is increased to a point about half that required for maximum plate current.

(3) With a white picture (approximately 30% sync, 70% video), the video gain is advanced until the r-f modulation envelope conforms to current FCC regulations, as observed on a modulation indicator[2] which will show relative percentage values.

(4) Should the transmission-line voltage be *low* (indicating insufficient power output), the r-f drive is raised to the modulated amplifier and the video signal increased until satisfactory modulation and transmission line voltage is attained. To determine the peak power output of the transmitter, the video modulating signal must be reduced to *black* (maintaining the previous input sync level) which will result in a standard black signal transmission comprising 25% of the total r-f amplitude as r-f synchronizing signal. The average power output should be measured under this condition of black signal. A water-cooled load terminating the transmitter output circuit, with means for determining the water inlet and outlet temperature differential and rate of flow, provides the most accurate measurement of this factor. The average power output thus determined is converted to peak power by obtaining the product of average power output and 1.68, the factor derived from consideration of the duty cycle of the sync pulse for conditions outlined above.*

[2]DuMont 5034-A r-f waveform monitor.

*Care must be continually exercised so that neither sync compression nor white saturation take place. The discussion of Figure 4 explains how these various discrepancies may exist and how corrective measures may be applied.

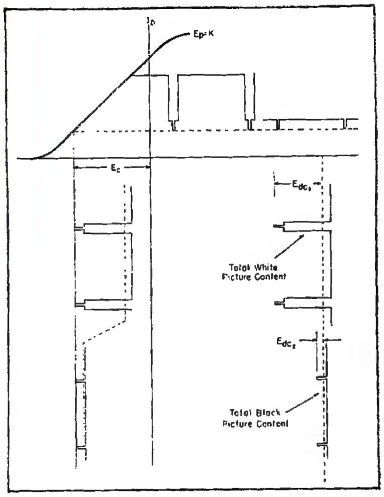


Figure 3

Curve illustrating a typical transfer characteristic of a video modulator for conditions of total black and white picture. E_{dc1} is the restorer potential for the white picture and E_{dc2} is the restorer potential for the black picture.

Proper adjustment of the foregoing three parameters above may be augmented by use of the following types of equipment:

(*1*) An r-f waveform oscilloscope which consists of provision for observing the modulation envelope and a beam deflection circuit for determining modulation percentages which is read on the meter. Such an instrument is shown in Figure 6.

(*2*) A diode pickup coupled to the transmission line whose output is connected to an ordinary h-f 'scope employing a scale calibrated in percentage. The input of the 'scope may be intermit-

Figure 1

Simplified circuit of a typical video amplifier, d-c restorer and video modulator.

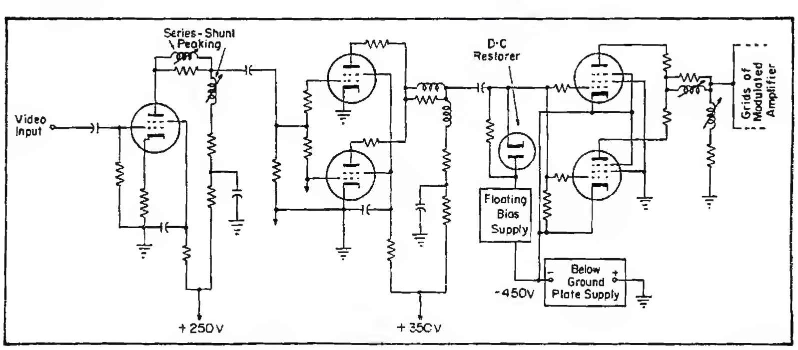
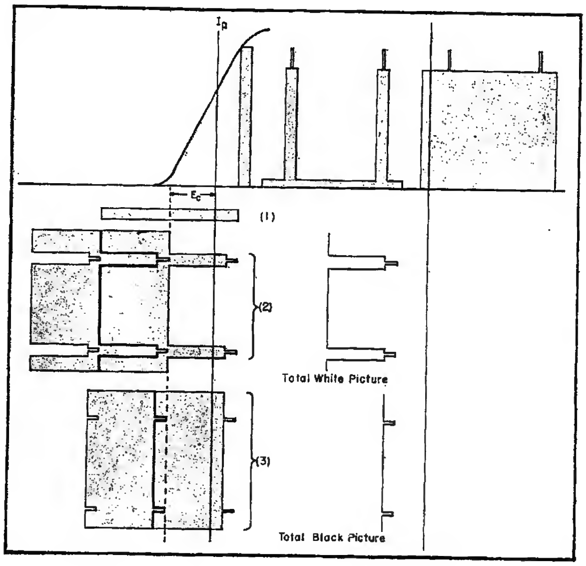


Figure 4

Transfer characteristic showing how (*1*) no picture, (*2*) white picture, and (*3*) total black picture modulates the r-f voltage applied to the modulated amplifier grid circuit, and the resulting plate current flow.



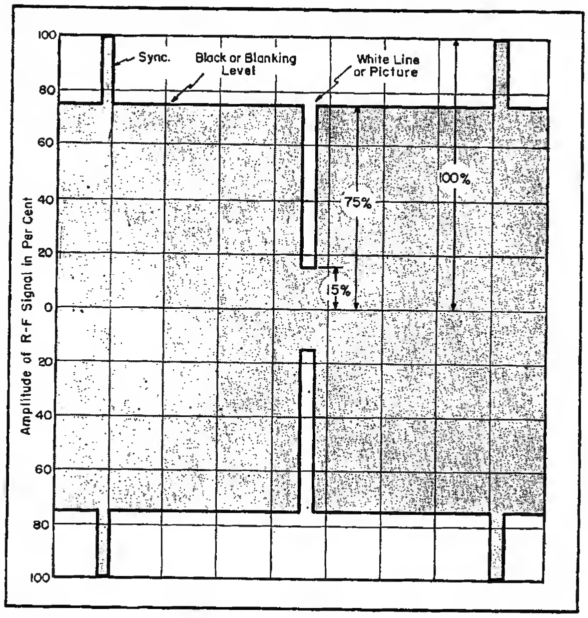


Figure 5
The r-f signal amplitude distribution for a black picture with a white line, as specified by the FCC.

tently keyed or shorted by means of a vibrator, to reclaim the zero reference axis, the total excursion being referred to this value. In any detecting system, there are two signal components, namely the d-c level, and the signal information. Periodic shorting of the input to the 'scope results in producing a *zero* reference level which represents *no signal*. This system allows measurement of the various modulation percentages. It is only necessary to adjust the 'scope gain for full excursion (with vibrator intermittently shorting the input). Relative amplitudes of modulation components are then measured directly.

Class B Linear Amplifiers

In the master[3] series transmitter, the modulated amplifier supplies driving power to a pair of WL-3300 tubes operating in class *B* (*intermediate-power amplifier*), followed by a second pair of WL-3300 (*power amplifier*) tubes. Grounded-grid circuits are used in both stages, which results in freedom from neutralization problems and a direct transfer of energy from the output of the *ipa* to the output of the *pa* providing a higher apparent final efficiency. The circuits are cathode driven which automatically loads the preceding circuit precluding the necessity for *bandwidth* resistive loading.

Linear amplifiers must be adjusted to satisfy four primary conditions:

(*1*) Satisfactory bandwidth.
(*2*) Adequate power output.
(*3*) Linear output between the limits of 100% and 15% modulation.
(*4*) Suppression of lower sideband.

Adequate bandwidth for tv, of the order of 4 mc, is attained by coupled circuits which consist of resonant primary and secondary, variable coupling, and variable secondary loading; a fundamental circuit is shown in Figure 7(*a*).**

A rapid review of coupled circuit theory shows that when two circuits which resonate at the same frequency are coupled together, the resulting behavior depends largely upon the coupling and secondary loading as shown in Figure 7. When the coefficient of coupling is small, the secondary response is low and varies with frequency according to a curve having a shape approximating typical resonance curves with only one peak. As the coupling is increased, the response increases in amplitude and simultaneously broadens. This trend continues until the coupling is such that the resistance, that the secondary circuit

(*Continued on page* 29)

**For a complete discussion of this subject see C. B. Aiken, *Two-Mesh Tuned Coupled Circuit Filters*. Proc. IRE; p. 230, February, 1947, and p. 672, June, 1937.
[3]DuMont.

Figure 6
Front panel view of the r-f wave-form monito

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

VWOA Memorial Awards

The Marconi Memorial Scrolls of Honor were awarded by VWOA to seven Army Transport Service radio operators who aided in rescues at sea during special ceremonies at the New York Port of Embarkation in Brooklyn, N. Y.

Ye prexy, W. J. McGonigle, presented the awards. Lt. Col. John D. Fleming of the New York Port of Embarkation was master of ceremonies and Maj. Gen. Ewart G. Plank, Commanding Officer of the Port, delivered the keynote address.

Four of the heroes were at the ceremonies to receive their awards while three others, who were at sea, were informed of their awards. At the ceremonies were Lt. Dale Clason, operator on the Army transport Belle Isle, who relayed a call for help from the Portuguese schooner, Maria Carlotta; Ensign Jack Chiaramonte, operator on the transport, Charles Stafford, who also relayed the call from the Maria Carlotta; Ensign Edward Nahan, another operator aboard the Charles Stafford, and Ensign Walter Fleming, who sent distress calls from the burning transport, Joseph Connelly, which was carrying war dead. The three radio men at sea who received awards were Winslow Lewandowski of the Charles Stafford and A. Donnary and Richard Astrauckas of the Belle Isle.

VWOA was quite proud to make these awards to these outstanding wireless men of the year.

W. J. McGonigle, VWOA prexy, presenting Marconi Memorial Scrolls to Ensigns Walter Fleming, Edward Nahan, Jack Chiaramonte and Lt. Dale Clason for their parts in rescues at sea. Major Gen. Ewart Plank, Commanding General, New York Port of Embarkation, is at extreme left.

At the Spring Meeting

There was quite a turnout at the Spring meeting of the VWOA which was held in the Marine Room of the Fireplace Inn in New York City on May 20.

VWOA honorary member, George Bailey, was guest speaker for the evening and told the boys about the United Nations' ham station at Lake Success. As prexy of the American Radio Relay League, George played a major role in setting up a coordinated plan for the amateurs of the world. He disclosed how the hams were united in this global plan to maintain contact with United Nations' headquarter amateur station K2UN and spread U.N. gospel.

The station, a one kilowatt affair, was placed in operation several weeks ago with many U.N. dignitaries in attendance. Honorary member Brig. Gen. Frank E. Stoner, who is chief of communications at United Nations, is directing the activities of this unusual good-will station.

Among those at the meeting were Ken Richardson, who reported that he was an operator way back in 1908 when he served with the United Wireless Company. . . . Ray Morehouse pulled out his old time records which showed that his brass pounding days began in 1917 with the United States Navy. After a two-year hitch with the Navy he became a commercial operator with the Panama Railroad Steamship Company. After three years at this post he decided that he'd like to sell the keys he had been banging and became a dealer on radio row in Cortlandt Street, New York City. He joined Allen D. Cardwell in 1924 and served them in various capacities until 1946. During the 1936 to 1946 period, he was the Cardwell sales manager. At present Ray is a sales rep for Adolph Schwartz handling Eimac tubes, Electro-Voice microphones, Cardwell condensers, R.M.E. receivers, Ward antennas, Petersen crystals and Sonar ham equipment. . . . Old timer Anthony Tamburino was also at the Spring meeting. A.T. had been a VWOA member for many years, dropped out for a spell and is now back with us again. His brass-pounding days go back to the S.S. America era. He was on the original staff of the S.S. Leviathan and also served with Prof. Wm. Beebe during the Galapagos scientific expedition in 1923. A.T. is now with the United States Navy at the Naval Shipyard in New York. . . . Old timer R. J. Iversen reported that the New York Times Radio station WHD has been moved into the new addition at the New York Times Building. All the equipment has been modernized and station facilities air-conditioned. The Times news summaries which are transmitted at 1900 GMT on 16,720 kc and 0500 GMT on 8360 kc have been received throughout the world.

Henry T. Hayden, Jr. was chairman of the meeting. Others at the meeting included C. D Guthrie . . . V. Villandre . . . Sam Schneider . . . Joseph L. Sarick . . . W. McDermott . . . H. H. Parker . . . E. M. Krause . . . R. H. Frey . . . ye prexy, W. J. McGonigle . . . E. P. Nelson . . . Lester Reiss . . . G. N. Mathers . . . R. H. Phesey . . . ye secretary, Wm. C. Simon . . . G. H. Clark . . . and ye editor.

News Briefs

INDUSTRY ACTIVITIES

WTVJ, Miami, Fla., is scheduled to go on the air by the end of July, with a 5-kw G.E. tv transmitter on channel 4.

Presto Recording Corporation is now located at Paramus, New Jersey, seven miles from New York City on Route 4, via the George Washington Bridge. Mail address P. O. Box 500, Hackensack, N. J.

Four divisions and subsidiaries of Raytheon Manufacturing Company are now located at 50 Broadway (telephone, WHitehall 3-4980); Equipment Sales Div., International Div., Russell Electric Co. annd Submarine Signal Co.
Raytheon's publicity department and Broadcast Equipment Sales remain at 60 East 42nd Street. The New York office of Belmont Radio Corp. is at 521 Fifth Avenue.

Crown Capacitor Corp., 316 Stuart Street, Boston, Mass., has been formed to produce a line of fixed paper capacitors.
J. H. McCulloch, previously with the Canadian Marconi Company, is chief engineer, and Joseph D. Blumenthal is general manager.

A 500-foot Blaw-Knox tower is being installed for WDTV, DuMont station in Pittsburgh. Station will operate on channel 3, 60 to 66 mc.

The Baltimore Police and Fire Departments will soon have a 215 mobile-unit FTR two-way system for its police cars, fire department vehicles, fire boats and harbor police patrol boats.
Central station transmitting antenna will be located on a tower on top of the City Hall building, some 300 feet above the ground. Two 250-watt transmitters are being installed in the central station, one for continuous duty and another for standby.

A two-way G.E. f-m system, KNDE (36.02 mc), is now in use at the Grand Coulee Dam in Washington.
Now installed aboard barges and tugs and in a ground station, equipment will soon be located on a mammoth floating caisson. Movement of this caisson, 115' long by 97' high steel structure, will be directed by f-m as it is maneuvered along the spillway to permit workers to make repairs.

A symposium on cathode-ray equipment and techniques, was presented recently by the Instrument Division of Du Mont at the Wardman Park Hotel, Washington, D. C.
Purpose of the symposium was to acquaint qualified government personnel of the Washington area with the latest advances in the cathode-ray art.
Speakers were Dr. P. S. Christaldi, W. A. Knoop, E. G. Nichols, M. G. Scheraga, and A. W. Janes, all of Du Mont.

WCIL-FM, Carbondale, Ill., is now on the air with a 1-kw W.E. transmitter. Antenna is a four-bay cloverleaf. Paul McRoy is general manager and Marion Sawyer, chief engineer.

WJR-FM, Detroit, will soon be on the air with a 10-kw W.E. f-m transmitter. Transmitter is being built into the wall of the master control room located on the twenty-first floor of the Fisher Building.
G. F. Leydorf is chief engineer.

A new television division has been set up in the G.E. Research Laboratory.
Clifford C. Fick, until recently division engineer of the receiver division, will head the new division.

PERSONALS

E. H. Vogel, manager of the radio sales division for G.E. from 1936 to 1939, has returned to the company as a member of the staff of Dr. W. R. G. Baker, vice president and general manager of G.E.'s Electronics Department.

R. J. Hartung is now controller of the radio tube division of Sylvania Electric Products Inc.

G. Robert Wannen, manager of Sylvania Electric's eastern radio tube sales division, died recently. He had been associated with the company for fifteen years.

Milton S. Roth has been appointed jobber sales manager for Radiart Corp., Cleveland, Ohio.

Murray G. Crosby has started the firm of Crosby Laboratories, 126 Old Country Road, Mineola, N. Y., where he will conduct a radio-electronic consulting practice. He was formerly with Paul Godley Co.

M. G. Crosby

N. F. Shofstall has been placed in charge of all engineering for the G.E. receiver division, with headquarters at Electronics Park. His new title is division engineer.
Shofstall succeeds C. G. Fick.

C. R. Schmidt has joined the staff of the Airlectron Engineering Company, P. O. Box 151, Caldwell, N. J., as assistant chief engineer.

Sidney Davidson has been named WPIX studio supervisor; William J. Kelly, transmitter supervisor; and Joseph Strockbine, supervisor in charge of transmitter maintenance.
Davidson and Kelly were formerly with NBC and Strockbine was with RCA.
Other engineers who have joined WPIX include Charles Anthony Voso, John F. Costello and Kenneth Petersen, formerly of WABD; Stanley Paul Palasek from CBS-TV; Michael Vardakis, formerly of Stewart Warner; Robert Lansing Maloof, from WGYN-FM; John R. Rieger, Jr., of the radio staff of the United Nations; Ephraim M. Abramson, a recent Carnegie Tech graduate; C. Russell Lea, Jr., formerly of WJBW, New Orleans and Armed Forces Network overseas; Dominick Bruno, Michael Freier and Harold V. Smith.

F. D. Meadows is now merchandise manager of the Broadcast Audio Group of the RCA Engineering Products Department.
Meadows will supervise the merchandising of broadcast audio equipment.

R. B. Rennaker has been appointed sales manager of the mobile radiotelephone division of FTR.

Rennaker joined Federal in 1945 as broadcast equipment sales engineer, subsequently became associated with Collins Radio and rejoined FTR recently.

R. B. Rennaker

J. C. Farley has been named general manager of the Radio Division, Sylvania Electric Products Inc.

Farley was formerly controller of the Radio Division.

J. C. Farley

Sanford H. Levey has been appointed sales manager of Allied Radio Corporation, Chicago.

LITERATURE

The Cannon Electric Development Co., Humboldt St. and Avenue 33, Los Angeles 31, Calif., have issued a new 32-page edition of its condensed catalog, the C-47 edition, covering the thirteen major type series of multi-contact electric connectors for radio, aircraft, communications, etc.

Also included in the catalog are data on d-c solenoids and signal equipment, etc.

Karp Metal Products Co., Inc., 129 30th Street, Brooklyn, N. Y., has published a 16-page catalog describing facilities for fabricating sheet metal cabinets, housings, enclosures, metal boxes, etc., and illustrating cabinets and housings for broadcasting transmitters, television equipment and electronic test equipment.

Utah Radio Products, Division of International Detrola, Huntington, Indiana, have released a 1948 radio replacement speaker catalog, No. 100.

Electrical and physical specs for speakers are listed in tables.

L. S. Brach Manufacturing Corporation, Newark, N. J., have published a 16-page catalog (No. 48-A) describing lightning arresters, gas relays, terminal strip, potheads, etc.

Standard Transformer Corp., Dept. B, Elston, Kedzie and Addison Streets, Chicago 18, Ill., have prepared a 24-page catalog (140-H). Listed are over 400 stock items, including audio and power transformers and reactors, power packs, volt adjusters, radio transmitter kits and television components. Also included are charts on transmitting tubes, driver-modulator combinations and matched power supplies.

Clarostat Mfg. Co., Inc., 130 Clinton St., Brooklyn 2, N. Y., have prepared a wall chart with type designations, brief specs, photographs and detailed drawings of standard controls, attenuators, fixed and adjustable resistors, flexible glass-insulated resistors, midget power resistors, ballasts and line-voltage-dropping resistors, power resistance decade box, television-tube beam-bender, and synchronous motors.

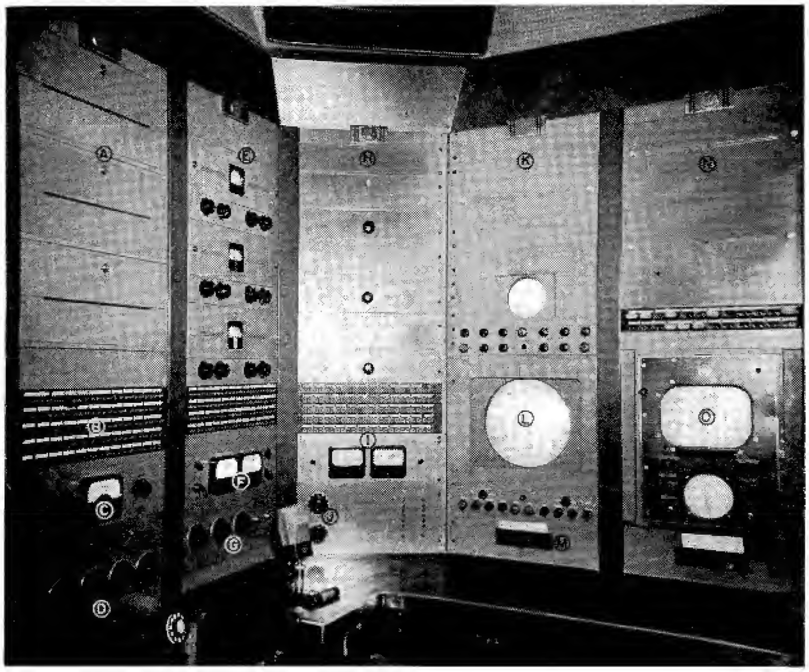
Radio City Products Co., 152 West 25th St., New York 1, N. Y., have published a bulletin, No. 133, describing hi-meg multitesters, the model 450 series, which includes six different units in open face models and in portable types.

Unit operates without batteries and tubes in the high ohmmeter circuit; provides resistance measurements of 50 to 1,000 megohms. Low-ohm range uses a single cell battery.

Electro-Voice, Inc., Buchanan, Michigan, have released a bulletin (No. 140), on *mobil-mikes* for commercial and emergency 2-way communications.

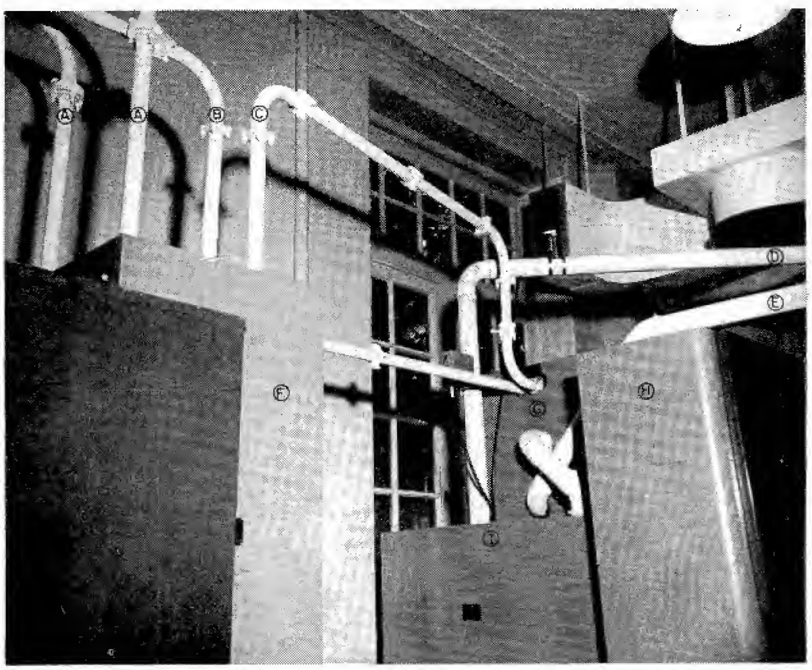
Data covers carbon, dynamic and differential carbon *mobil-mikes* for aircraft, police, fire, taxi, marine, utility, forestry, and similar services. Includes listing of carbon *mobil-mikes* for exact replacement in current Motorola, RCA, G.E. and similar mobile equipment.

NBC TV/F-M In Washington, D. C.



Above, control equipment setup at WNBW (66-72 mc)/WRC-FM (93.9 mc), Washington, D. C. In *a* appears the audio frequency preamp for f-m and tv. A jack feed is at *b*. At *c* we have a volume indicator and at *d* input controls. A limiting amplifier is shown at *e* and the volume indicators are at *f*. At *g* is the transmitter input control which permits switching of the entire spare a-f chain to either transmitter. Monitor amplifiers are at *h* and repeaters of percentage modulation are shown at *i*. The monitor control panel with switching, which permits listening to tv sound, f-m, or off-the-line material is at *j*. At *k* is the master monitor and power supply and at *l*, the master monitor for NBC. Master monitor switching is at *m* and at *n*, the master monitor and power supply. At *o* is an RCA tv receiver.

In view below, at *a*, are the lines to the antennas. At *b* is the line to f-m and at *c* is a quarter-wave transmission line for the television system. At *d* is the line to the tv picture transmitter, while in *e* is the line to the tv sound transmitter. At *f* is the triplexer in which there is an extra quarter-wave setup for f-m. At *g* is the diplexer and at *h* the dummy load. The vestigial side-band



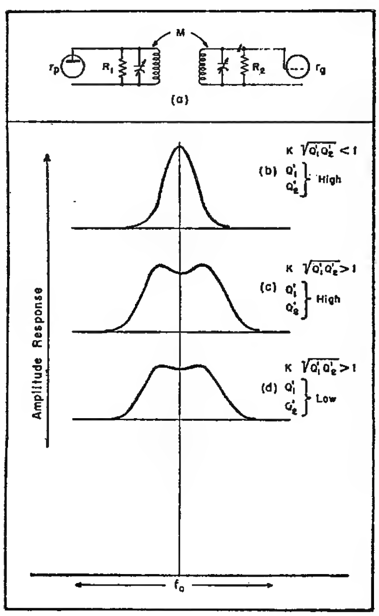
TV Transmitter Design

(*Continued from page* 22)

couples into the primary at resonance, is equal to the primary resistance. This coupling is called *critical coupling* and causes the secondary response characteristic to have the maximum possible value it can attain; Figure 7*b*. If the coupling is increased beyond critical coupling the secondary response begins to show double humps with the peaks becoming progressively more pronounced and further apart as the coefficient of coupling is increased. It is important to note, in the practical case, that when the loaded and unloaded circuit Q's are not equal, the double humps do not appear in the secondary response until the coupling is somewhat greater than the critical value. A curve showing the effect of greater than critical coupling is illustrated in Figure 7*c*. Where the Q of the circuits is high, the double peaks will be quite sharp resulting in a pronounced valley between the peaks. This effect may be reduced by increasing the secondary load, which will lower the double peak response and make the overall characteristic more *flat topped,* as shown in Figure 7*d*.

[*To Be Continued*]

Figure 7
At *a* appears a fundamental coupled circuit, and at *b*, *c*, *d* we have the effect of coupling and circuit loading.



TV Antenna

(*Continued from page* 14)

banding stub as shown, with the cable shield bonded to the leg at several points along its length. Under this condition the cable shield becomes an integral part of the stub conductor, but since the diameter of the shield is small compared to that of the stub conductor there is no serious alteration in either the Z_0 or the balance of the broad-banding stub. Hence, the signal delivered to the coaxial line from the antenna system is essentially only that energy which is derived from the dipole elements, with no extraneous contributions from any signal components which may be picked up on the outer surface of the coaxial-cable shield.

As an alternative coaxial-fed arrangement, the dual-band antenna conductors may be fabricated of tubing and the coaxial cable then inserted up through the center of one of the stub legs via a hole in the bottom bend. It may then be brought out through another hole in the corresponding top bend, and the shield and center conductor connected as before. Although this method is somewhat better electrically than the one described in the preceding paragraph, it may result in some sacrifice of mechanical strength occasioned by the use of tubing instead of solid rod.

Gain-Producing Arrays

To obtain a dual-band antenna array with greater directivity (and therefore higher gain) than that of a normal dipole, two or more antenna assemblies may be combined in various fashions. Figure 8 illustrates a *V* arrangement whereby one dual-band antenna assembly is used as a parasitic reflector element for another dual-band antenna. The assemblies are attached to a common mounting base and inclined 60° with respect to each other, each one being inclined 30° from vertical. The 60° inclination between antenna systems is the value required to produce a quarter-wave spacing both between the high-band dipole and its reflector element and between the low-band antenna and *its* reflector. The shorting link shown across the feed point of the reflector is the only short-circuiting device necessary, since it automatically reflects a short circuit across the high band parasitic element in the proper frequency range.

For still higher gain and directivity than described in the preceding paragraph, four assemblies may be combined in an *X* type of array, as

sketched in Figure 9. Here the pair of assemblies described in the preceding paragraph is combined with a similar pair, inverted, with the entire combination supported from a central mast through which is fed the balanced transmission line which connects the array to the receiver. The upper and lower *V* assemblies are fed in parallel, as shown, although the impedance properties are not as favorable for this array as they were for the preceding antenna systems.

The dual-band antenna system has also been found to reject signals which occur in the neighborhood of 140 and 280 mc, i.e., at the frequencies where the broad-banding stub is an integral number of half-wavelengths long. This action takes place because the stub reflects a short-circuit across the feed point at these frequencies. This property is useful in rejecting interference from signals in these frequency bands, so that the image ratio of the overall receiver-plus-antenna system is hence improved.

Use With 300-Ohm Line

Another feature of this antenna system is that, although its impedance is nominally about 70 ohms, its use in conjunction with 300-ohm transmission line, properly terminated by the receiver input impedance, will generally result in an improvement of signal-to-noise ratio (or noise figure). This well-known effect takes place because the noise level (referred to the input circuit) of most tv receivers is from 10 to 18 db above thermal noise, whereas the noise from the antenna resistance is substantially at thermal level. Hence, mismatching the antenna to the receiver in the manner indicated will result in a measurable improvement of signal-to-noise ratio, while not seriously impairing the bandwidth of the system.

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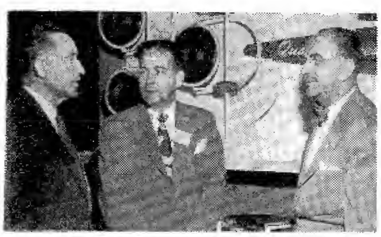
AT NAB MEETING



S. P. Taylor (left), manager distributor sales, W.E. Radio Division, discussing the W.E. 728 loudspeaker with Neal McNaughten and Royal V. Howard of the NAB engineering department, at the recent NAB Convention in Los Angeles.

TUBE *Engineering News*

WITH THE ACCELERATED INTEREST in commercial s-h-f work has come an increased demand for special types of s-h-f tubes, such as the magnetron, particularly in wide-range tuning systems. Many projects devoted to the development of such systems have been set up.

Describing one such research program at the recent IRE National Convention, E. Navin Kather, of Raytheon, pointed out that the ultimate design requirements of any wide-range tunable magnetron are linear tuning, uniform input current and voltage, constant power output and efficiency, and a high order of stability.

These are substantial requirements to meet. We find, for instance, that the electronic efficiency of a magnetron of fixed anode and cathode diameter and length will change as its resonant frequency is varied. If constant input voltage and current are to be obtained, the magnetron will require a varying magnetic field over the tuning range. However, a change of the magnetic field will aggravate the variation of the electronic efficiency which results from changing the resonant frequency of the magnetron. Introduction of a tuning element into the resonant circuit of the magnetron usually is accompanied by increased losses and lower circuit efficiencies, especially if the tuning element is resonant at any frequency through which the magnetron is tuned. These losses are reflected in lower overall Q values.

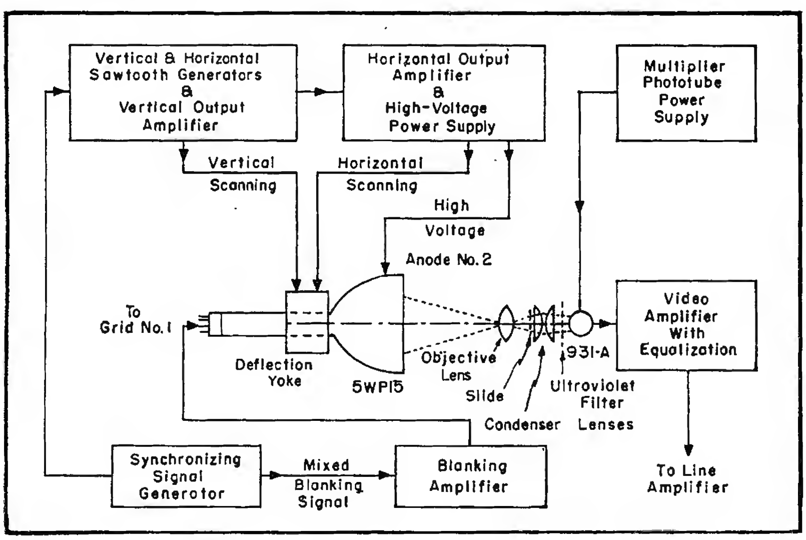
Satisfactory magnetron performance is dependent on a proper separation of its resonant modes. The tuning element usually changes this mode separation, and if not restricted may prevent operation of the magnetron in the *pi* mode at the required power input.

It is possible to secure wide-range tuning with mechanical systems where the resonant frequency of the magnetron is changed by moving some element in the associated resonant circuit. From the mechanical viewpoint, these systems may be divided into four groups; coupled reactive, capacitive, inductive, and combination capacitive-inductive systems. Any one of these groups may be symmetrical or unsymmetrical in relation to the magnetron resonant circuits. The circuit elements of a symmetrical system are varied in a manner that preserves angular symmetry about the magnetron. In the unsymmetrical system, this angular symmetry is not preserved.

Defining the coupled reactive system Kather said that in this system the resonant frequency of the magnetron is varied indirectly by a second resonant circuit coupled to the magnetron. Such a system offers an advantage, since the coupling circuit may be external to the magnetron and thus not confined to the limitations imposed by the magnetron geometry. The coupled resonant circuit, however, introduces new modes in the magnetron mode spectrum and, because of the stored energy in the coupled circuits, increases the stabilization of the magnetron. The increased stabilization usually increases the tendency of the magnetron to operate in undesired modes and, therefore, must be limited if satisfactory operation over a wide tuning range is to be obtained. These inherent properties limit the useful tuning range of such systems to about 10%.

Figure 1

Block diagram of flying-spot video-signal generator system for slide transparencies.



Capacitive-Tuning System

In the capacitive tuning system the capacity of the magnetron resonant circuit is varied directly. The most successful systems accomplish this variation by changing the strap or vane capacity. The strap capacity tuner or *cookie cutter* generally takes the form of a third ring inserted between the straps of the magnetron. In the vane type tuner we usually have a set of *fingers*, sometimes referred to as a *sprocket* or *crown of thorns*, which is inserted between the vanes comprising the resonant cavities of the magnetron. These *fingers* are confined to the capacitive portion of the cavities and, since the greater part of the total capacity in the magnetron resonant circuit is usually contained in this region, greater tuning ranges are obtained by using the vane capacity system. A capacitive system requires close spacing for greatest tuning range and, therefore, is subjected to voltage breakdown limitations.

Inductive-Tuning System

In the inductive-tuning system, the inductance of the magnetron resonant circuit is varied directly. This system may take a form similar to the vane type capacitive tuner, excepting that the *fingers* are inserted into the inductive region of the magnetron resonant cavities, thus varying the inductance thereof. Such systems usually introduce greater losses and are, therefore, limited in application.

Kather disclosed that a combination of the capacitive and inductive systems yielded a system which would give the greatest tuning range. This combination system consists of capacitive fingers joined to inductive fingers, so proportioned with respect to the anode that proper movement of the tuner will result in maximum inductance, maxi-

mum capacitance or minimum inductance, minimum capacitance, or all degrees in between.

The case of a 200-watt c-w magnetron, tunable from 3,500 to 5,500 mc, was used by Kather to illustrate how the problem of designing a wide-range tuning system was solved.

A vane-type capacity tuner of linear characteristics was chosen for use in this particular magnetron because the voltages were relatively low and close spacing between the tuner and vanes of the magnetron resonant cavities could be tolerated. The undesirable inductive effect of the tuning *fingers* was considerably reduced by cutting a *V* slot in the back of each finger, thus minimizing the disturbance to the r-f field and resulting in a 22% increase of the tuning range. A variation of the magnetic field required for constant-input voltage and current was accomplished by arranging one magnetic pole face so that it would move with the tuner system, noting that as the capacitive *fingers* were inserted, the resonant frequency was lowered and a higher magnetic field was required to maintain constant input voltage. This variation in magnetic field must be accomplished without producing excessive distortion in the interaction space of the magnetron.

As the magnetron is tuned, both the resonant frequency and magnetic field are changed, resulting in a wide variation of the electronic efficiency over the tuning range. Compensation for this variation was obtained by designing the output coupling circuit so as to vary the circuit efficiency inversely with respect to the electronic efficiency and yet maintain reasonable stability. Satisfactory circuit efficiencies over the entire tuning range could not be obtained until the resonant modes of the tuning system were determined and adjusted. Kather pointed out that, unfortunately, a tuning system designed to mesh with the resonant cavities of a magnetron is necessarily comparable in size and, since the tuner system resonates in much the same fashion as the magnetron cavities to which it is coupled, the natural resonant modes of the tuning system are normally close in frequency to those of the magnetron. The tuner assembly was, therefore, designed so as to move its family of resonant modes out of the magnetron tuning range and yet provide adequate dissipation of the r-f losses.

Performance tests on this magnetron showed that the tube had a tuning ratio of 1.57:1 with a power output variation of 12% and input voltage variation of only 4% over the entire range.

Wide-Range Tuning System for Magnetrons . . . Flying Spot C-R Tube . . . Notes on Interchangeability of 5516 and 2E24.

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Flying-Spot Cathode-Ray Tube

A FLYING-SPOT cathode-ray 5″ tube, 5WP15, which permits the telecasting of individual station call letters and test patterns from interchangeable slide transparencies or from opaque surfaces, has been developed by RCA.

The tube, which has a metallized back, furnishes a small, rapidly moving spot of radiant energy for scanning a slide transparency or opaque object.

Featured in the 5WP15 is a new short persistence phosphor having a large component of its energy emission in the near ultraviolet region. The persistence of the ultraviolet radiation is so short that the amount of equalization needed in the video amplifier to minimize trailing in the reproduced picture is small and can be supplied by a single network.

Magnetic deflection and electrostatic focus are utilized to permit obtaining essentially uniform focus over the useful screen area. Other design features include an external conductive coating on the neck which, when grounded, prevents corona between yoke and neck, built-in capacitance between interior and exterior neck coatings to serve as a filter capacitor for the high-voltage power-supply unit, an external insulating coating on the bulb cone to minimize sparking over the glass bulb under high humidity conditions and a duodecal 7-pin base for high-voltage service.

Flying-Spot Video-Signal Generator

A flying-spot video-signal generator consists essentially of a flying-spot cathode-ray tube with associated power supplies, deflection yoke, and scanning circuits to provide a small, rapidly moving source of radiant energy, optical system arranged to project the raster on the subject to be scanned, subject which may be a slide transparency, motion picture film or an opaque object, multiplier phototube with associated power supply to intercept the radiation transmitted or reflected by the subject and convert it into video signals, and an amplifier to increase the strength of the video signals.

A setup of such a system arranged for use with a slide transparency appears in Figure 1. For best results, the objective lens must be a high quality, enlarger type designed for low magnification and preferably corrected for use with ultraviolet radiation. The diameter of the objective lens should be adequate to cover the slide to be scanned. For use with 35-mm slides, the Kodak Enlarging Ektar f:4.5 lens with focal length of 100 mm, or equivalent, is suitable.

For absorbing the visible and passing the ultraviolet radiation of the screen the Eastman Wratten Nos. 18A, 34, and 35 as well as the Corning Nos. 9863 and 5970 filters can be used. The choice of filter for a particular generator design is affected by a compromise between the permissible loss of signal output through absorption by the filter on the one hand, and the amount of trailing which can be tolerated, or the extent of equalization needed, on the other hand.

Trailing results from the lag in buildup and decay of output from the screen. As the flying spot moves across a boundary from a light to a dark area of the subject being scanned, the persistence of energy output from the screen results in continued input to the phototube from the light area during the time the dark area is being scanned. Thus, the light area trails into the dark area in the reproduced picture. Similarly, as the flying spot moves from a dark area to a light area, the lag in buildup of the screen output causes the dark area to trail over into the light area. As a result of these effects, the reproduced picture has an appearance similar to that produced by a signal deficient in high frequencies. It is, therefore, necessary to enhance the high-frequency response of the video amplifier by introducing equalizing networks of the resistance-capacitance type with suitable time constants. Sufficient equalization should be provided to give the desired square-wave response.

The decay characteristics of most standard phosphors are such as to require considerable equalization provided by networks with different time constants in several stages of the video

(*Continued on page* 36)

Maintenance

(*Continued from page* 16)

cations receivers, we first applied a 5-microvolt signal at 13 mc through 70 ohms to the input of the receiver, sensitivity maximum and avc on. We then recorded the output across a 600-ohm load for conditions of signal unmodulated and signal modulated 30% at 400 cps. A receiver in good condition might give an output in the latter instance of 20 db higher than in the former case. A borderline receiver, which is beginning to show noticeably decreased sensitivity during normal operation might give readings differing by only 10 db. Depending upon the conditions of operation, a limit might be set, such that any receiver giving a difference of less than 14 db is regarded as unsatisfactory and is removed for repair before it hampers operation.

Inspection procedures must be designed to reduce the number of failures during operation. The actual inspection may be as valuable as any part of the procedure. It is intended that if possible inspection procedures be carried out at such times as the equipment is normally idle so they do not require interruption of service. The same is true of replacement of equipment found defective by these inspections.

Maintenance Procedures

The purpose of maintenance procedures is to prolong the useful life of equipment, to reduce the total number of failures in operation and rejections by periodic inspection. These procedures will thus necessarily include their own inspection. They will be complete and include their own set of performance standards. The repair procedure for the aforementioned receivers might include six steps:

(*1*) Inspection procedure, if it has not been done.

(*2*) If trouble is mechanical, processing of necessary repairs.

(*3*) If trouble is sensitivity, checking of tubes (testing sensitivity if replacements are made) and realignment if required, plus an additional sensitivity test.

(*4*) If trouble is failure of component, determining cause, correcting and replacing of part.

(*5*) Cleaning and examing for signs of overheating and deterioration.

(*6*) After 72 hours of operation, another inspection procedure.

In this example, the emphasis is on finding specific difficulties and correct-

ing them, then making sure the receiver is in good condition. Inspection is stressed rather than repair because unnecessary work is costly and sometimes introduces more difficulties than it eliminates. This imposes severe requirements on the tests applied at the completion of the repair work.

The test part of the inspection procedure is applied most successfully to r-f equipment. Mechanical equipment often responds best to visual inspection. Since this inspection may require partial dismantling of the equipment, it can conveniently be combined with cleaning and lubrication of the machines. The combined maintenance-inspection procedure must be undertaken at regular intervals.

Analysis Procedures

In order to arrive at effective *inspection* and *maintenance procedures* for any operational system, the results of a large number of experiments must be recorded and evaluated. The starting point will, of course, be the best accepted practices. After some weeks, shortcomings in these practices will be detectable and changes to be made in the procedures will suggest themselves, a step to be added here or a requirement to be relaxed there, the frequency of inspection on a certain unit to be changed. The value of these changes must, by some simple and accurate means, be made evident.

The information required for this evaluation is found in the record of failures in service and rejection during inspection. If servicing of all equipment is centralized in one location, a simple form such as that shown in Figure 1 may suffice for the record of failures in service. The *time reported* and *time repaired* entries disclose the length of time the unit is out of service. The *action taken* entry tells what the conditions of service were in the meantime. *Trouble reported* and *trouble found* are both recorded because they are not necessarily the same and they may indicate the need for instructing operating personnel. Finally, the repairman's name is required for evaluation of his competence.

The *equipment and number* column in the *trouble log* provides reference to an *equipment repair record card,* Figure 2. Each individual of a group of identical units must be numbered and a card kept for it. These cards are used as a current status report on individual items. They make it possible to spot individuals which are not conforming to the average of performance.

The *inspection procedures* are, of course, outlined in such form that they are readily available to the people concerned. It is only necessary, then, that certification be made that the prescribed procedures have been carried out and the units found unacceptable listed on the *inspection report* of Figure 3. Here again we find it is possible to transcribe pertinent data to the *repair record card.* The designation number of name of the *inspection procedure* appears in column *3*, and a description of the defects found in column *4*. Names of inspector and workman are required as certification, and the time required for repair is needed for totalling repair costs.

The *inspection reports, trouble logs,* and certification of performance of *inspection procedures* for any period contain all data concerning equipment failures, and repairs over that period. It remains only to summarize the information and determine significant relationships. This is a simple clerical

(*Continued on page* 36)

(Continued from page 35)

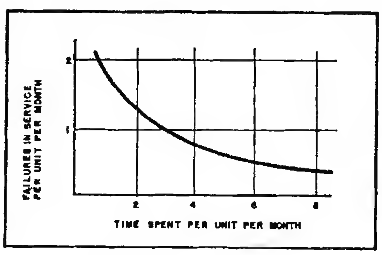
task requiring only a slight acquaintance with the terms encountered in the records. Figure 4 illustrates a convenient form on which this summarization may be made.

As indicated by line *1*, a sheet of this kind is kept for each type of equipment under consideration. A summarizing period of one month is shown because it is convenient for most purposes. The breakdown of *failures in service* and *inspection rejections* can be made as detailed as desired. Greater detail is likely to be required as the most common difficulties are eliminated and the factor entered on line *8 decreases.* Care should be taken to enter on line *6* only the total time in *unit hours* (similar to *man hours*) that equipment was impeding operation.

The primary object of this whole program is to reduce the service interruption per unit, line *9*, to as low a value as possible. A great deal can be done toward this end in some cases by providing spare units which can be put into service almost instantly. The secondary purpose is to reduce the entries on lines *4*, *7*, and *10*, to values as low as practical. Here the inspection and maintenance time, line *12*, comes into the picture. If the cost of failures in service can be calculated, the problem simplifies to one of balancing failure cost against the cost of inspection and maintenance time. If the failure in service cost cannot be determined, a carefully considered decision must be made as to the permissible magnitude of the quotient in line *14*. For example, one type of recording apparatus exhibited the failure characteristic shown in Figure 5 over a period of several months. This clearly defined characteristic was obtained only after some months of developing the inspection procedure and training the people who actually made the inspections. Knowing how many failures can be accepted, an engineer responsible for this equipment has little difficulty including how much time has to be spent on the equipment.

Figure 5

Typical record of failure of equipment over a period of months; time spent in inspection and maintenance, not in repairing failures in service, being recorded.



Other equipment may not show such simple characteristics, especially when a program of this sort is first begun. Occasionally a type of equipment will be found which refuses to respond to inspection or to regular maintenance. If the trouble rate is low, the equipment is evidently well designed and constructed. If the trouble rate is high, the inspection and maintenance procedures should be examined with more than ordinary care; and finally, modification of the units should be undertaken. The record of troubles will point to the modifications required.

Tube News

(Continued from page 33)

amplifier. Their relatively long decay generally results in appreciable reduction of the useful signal-to-noise ratio. The persistence of the phosphor used in this tube, however, is comparatively so short that less equalization is needed. If the tube is used without an ultraviolet filter, less equalization is required than for other standard phosphors but a complex network is nevertheless needed because the decay characteristic is not a simple exponential curve but a curve of a complex function.

Grid *2* is incorporated in the 5WP15 to prevent interaction between the fields produced by grid *1* and anode *1*. However, grid *2* may also be used to compensate for the normal variation to be expected in the grid *1* voltage for cutoff in individual tubes. By adjusting the voltage applied to grid *2*, with due consideration to its maximum rated value, it is possible to fix the grid *1* bias at a desired value, and obtain almost the same anode-current characteristics for individual tubes having different cutoff voltages. Adjusting grid *1* cutoff in this way not only makes grid drive more uniform, but also reduces variations in anode *1* current. Since grid *2* draws at most only negligible leakage current, its voltage may be obtained from a potentiometer inserted in the anode *1* voltage divider.

The d-c power supplies for the 5WP15, which should be well filtered, consist of a high-voltage type (20,000-volt for recommended operation) preferably of the limited-peak-energy type, i.e., one in which the peak current even under short-circuit conditions is well below the value dangerous to life, for anode *2*, and a negative supply of about 100 volts, depending on equip-

ment design, for grid *1*. Voltage for anode *1* is obtained by means of a voltage divider across the high-voltage supply.

Soft x-rays are produced when the tube is operated with an anode *2* voltage above approximately 20,000 volts. These rays can constitute a health hazard unless the tube is adequately shielded. Relatively simple shielding should prove adequate, but the need for this precaution must be considered in equipment design.

Resolution of better than 700 lines at the center of the reproduced picture can be produced. To obtain such resolution in the horizontal direction, it is necessary to use a video amplifier having a bandwidth of about 10 mc.

The screen of the 5WP15 has radiation in the visible blue-green region and in the invisible near-ultraviolet region. The blue-green radiation decays hyperbolically to about 30 per cent of its initial value in 1.5 microseconds. The ultraviolet radiation has an equivalent exponential decay with a time constant less than 0.05 microsecond. The frequency response of the ultraviolet radiation is substantially constant for a range of 3 mc and then decreases exponentially toward zero at approximately 100 mc.

[*Data based on copyrighted material supplied by RCA.*]

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Interchangeability Of 5516 With 2E24

THE 5516 IS directly interchangeable with the 2E24, although when the tubes are interchanged without circuit changes the 5516 will be operating with less power input than the 2E24, because the 5516 normally requires a higher screen potential.

When a direct substitution is made without any circuit changes, there will be a corresponding reduction in power output, the efficiency remaining essentially the same, because of the lower plate power input.

To utilize the full capabilities of the 5516, it is generally necessary to increase the screen voltage of the 5516. In sets using a series screen dropping resistor, this is accomplished by decreasing the value of this resistor, or by shunting another resistor in parallel with the original one. As high as 250 volts may be applied to the screen of the 5516, this voltage being measured when the equipment is properly tuned and delivering power to the load. A change in the value of the control grid resistor may be required in some equipments. If this is necessary, a lower value of control grid resistor will usually be needed.

When a set is modified for the use of the 5516 or designed to use a 5516, it is not generally possible to replace the 5516 directly with a 2E24. This is because the 5516 operates at a somewhat higher screen voltage (above the maximum rating for the 2E24) and because the 5516 carries higher ratings.

Typical modifications required for control grid and screen grid resistors when the 5516 is used in place of the 2E24 (when the 5516 or 2E24 is used as a doubler driver) are:

Resistor	*2E24*	5516
Control-grid resistor	100,000 ohms	50,000 ohms
Screen-dropping resistor	27,000 ohms	13,500 ohms (10 w)

The following data are applicable when two 5516 or 2E24 tubes are used as push-pull amplifiers:

Resistor	*2E24*	5516
Control-grid resistor	27,000 ohms	10,800 ohms
Screen-grid resistor	12,500 ohms (10 w)	8,500 ohms (10 w)

[*Data courtesy Hytron.*]

The Industry Offers

RCA MINIATURE BROADCAST MICROPHONE

A midget 12-ounce microphone has been developed by the RCA engineering products department.

The microphone is said to have an output level comparable to that of conventional broadcast studio types.

* * *

GOTHARD MOBILE TRANSMITTER DYNAMOTOR

A dynamotor, designed especially for mobile transmitters, model GP-26, has been announced by the Gothard Manufacturing Company, 2110 Clear Lake Ave., Springfield, Illinois.

Dynamotor is available with power output ranging up to 80 watts continuous and 150 watts intermittent duty. Voltage regulation averages 19%, with the unit efficiency about 61%. Weight is 8¼ pounds, with the height of the unit 4", frame diameter 3½", and the length 7¼".

Further information may be obtained from M. A. Winkel, sales manager.

* * *

HEWLETT-PACKARD BATTERY-OPERATED VOLTMETER AND OSCILLATOR

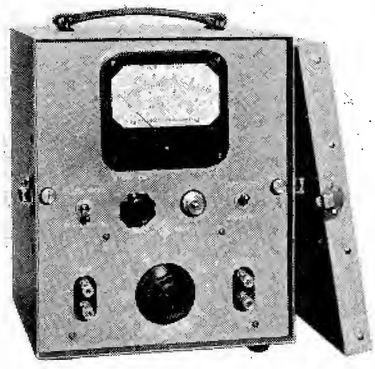
Two battery-operated instruments, a vacuum-tube voltmeter (404A) and audio oscillator (204A) have been announced by Hewlett-Packard Company, 395 Page Mill Road, Palo Alto, California.

The audio oscillator has a frequency range of 2 cps to 20 kc in decade ranges. Stability is said to be better than ±3% throughout frequency range. Output is 5 volts into a 10,000-ohm load, and frequency response is said to be flat within ±1 db between 2 cps and 20 kc.

The instrument is tunable directly or by a 6-to-1 vernier micro-drive control. Five flashlight and three standard 45-volt *B* batteries are accessible, mounted in rubber-lined anti-corrosive case, and balanced for over 60 hours life.

The battery-operated vacuum-tube voltmeter is designed for a-c measurements from 2 cps to 20 kc, with useful range extending to 50 kc. Voltages from .001 to 300 can be measured.

Input impedance is 10 megohms shunted by a capacity of approximately 20 mmfd. Accuracy is said to be ±3% over a range of 2 cps to 20 kc, ±7% from 20 kc to 50 kc of full scale including all error due to tube aging, warm-up, and battery voltage changes. The meter is calibrated to read rms value of a sine wave. Voltage scale is linear, and a db scale is also provided from —12 to +2. Each voltage scale is related to the next by exactly 10 db. Continuous db readings can be made from —62 to +52 db. (Zero level equals 1 mw in 600 ohms.) Eleven voltage ranges are selected with a single switch. For measurements below 10 cps, a damping capacitor is available to reduce meter point vibration.



Hewlett-Packard 404A

* * *

CALIFONE PORTABLE TRANSCRIPTION PLAYER

A portable transcription unit, model 6-A, which plays up to 17¼" transcriptions at 33 1/3 rpm and regular phono records at 78 rpm, has been developed by the Califone Corp., 1041 N. Sycamore Ave., Hollywood 38, Calif.

Unit features a ¾-ounce pickup, 9" turntable, wide-range amplifier. Models availabe for a-c or a-c/d-c operation.

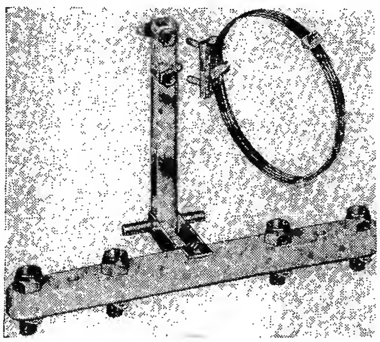
WHEN YOU CHANGE YOUR ADDRESS

Be sure to notify the Subscription Department of COMMUNICATIONS, 52 Vanderbilt Avenue, New York 17, N. Y., giving the old as well as the new address, and do this at least four weeks in advance. The Post Office Department does not forward magazines unless you pay additional postage, and we cannot duplicate copies mailed to the old address. We ask your cooperation.

JOHNSON INDUCTORS

A line of air-wound inductors and swinging-link assemblies has been announced by E. F. Johnson Co., of Waseca, Minnesota.

Inductors are supported on polystyrene. Available in 150-, 500- and 1,000-watt ratings.



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AEROVOX TUBULAR CAPACITORS

Duranite cased tubular capacitors have been announced by Aerovox Corporation, New Bedford, Mass.

The casing material, developed by Aerovox is said to provide a permanent rock-hard seal heretofore expected only of metal-cased capacitors.

HYTRON 3B4 V-H-F BEAM PENTODE

A v-h-f beam pentode power amplifier, the 3B4, developed to meet U. S. Signal Corps application requirements, has been announced by Hytron Radio & Electronics Corp., 76 Lafayette Street, Salem, Mass. A filamentary-type miniature, the tube is particularly suited to portable/mobile operation from R-M cells or ordinary dry cells.

Instant-heating feature of the 3B4's 1.25/2.5-volt filament is said to eliminate filament drain during standby. Full ratings are applicable up to 100 mc; as a class C amplifier, the 3B4 delivers approximately 1.25 watts.

The 3B4 can be used as an r-f oscillator/amplifier or frequency multiplier in transmitting equipment for civilian light aircraft.

The 3B4 is through its pilot run and is now in regular production. Engineering samples are being shipped from stock.

* * *

FURST REGULATED POWER SUPPLIES

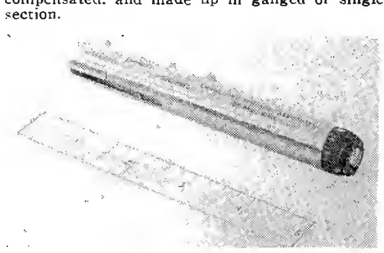
An electronically-regulated power supply, designed to serve as a source of d-c power at high voltage and low current, has been announced by Furst Electronics, 800 West North Ave., Chicago 22, Ill.

Two or three independently regulated and independently adjustable outputs are available on models 710-2 and 710-3. Regulated output voltage is continuously adjustable over a range of less than 600 to over 1,500 d-c at 0.1 ma per channel.

ENGINEERING RESEARCH ASSOCIATES MINIATURE VARIABLE CAPACITOR

A miniature variable capacitor, with a capacity of 9 to 585 mmfd per section has been announced by Engineering Research Associates, Inc., 1902 West Minnehaha Avenue, St. Paul, Minnesota.

Capacitor is said to have less than .002 dissipation factor at r-f. Has self-contained dial with micrometer action. May be temperature compensated, and made up in ganged or single section.



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DAVEN MINIATURE CONTROLS

A line of miniature attenuators has been announced by the Daven Company, 191 Central Avenue, Newark 4, N. J.

Types include a 1¾" ladder type (LA-130) with 30 steps; a 2¼" ladder (LA-745) with 45 steps; a tee type, 2¼" in diameter (T-730) with 30 steps; and a 2¾" tee type for 45 steps.

ADVERTISERS IN THIS ISSUE

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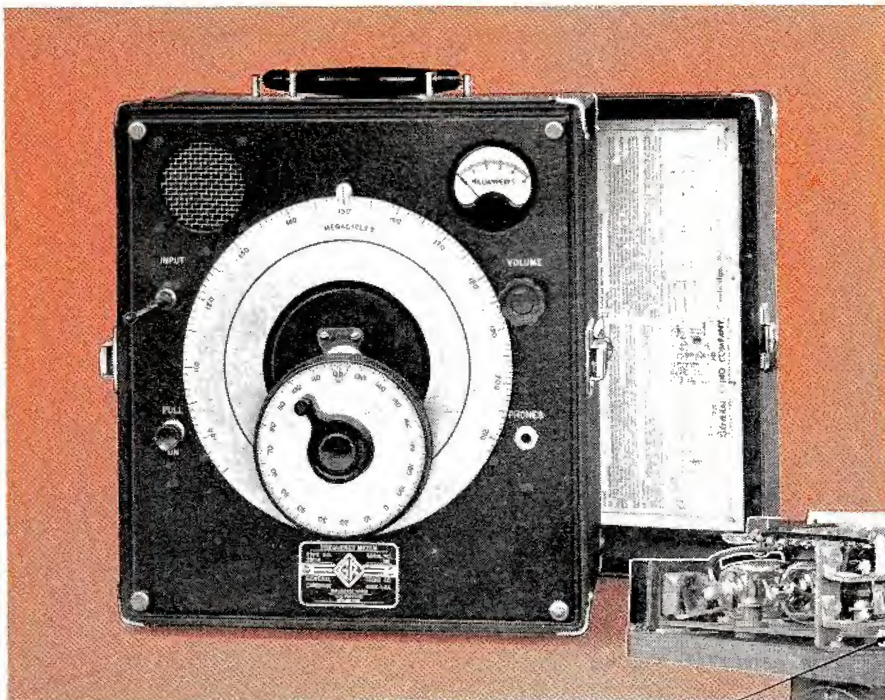
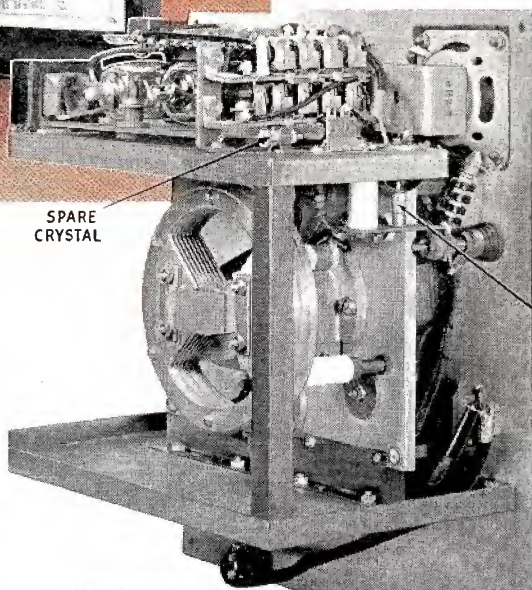
JUNE, 1948





FREQUENCY MEASUREMENTS TO 3,000 Mc

FULL advantage of the simplicity of the heterodyne method of frequency measurement is taken in this frequency meter. With a fundamental range of 100 to 200 megacycles, accurate frequency measurements may be made between 10 and 3,000 megacycles.

The tuning circuit is our butterfly type with no sliding contacts, obviating many of the difficulties encountered in the usual tuning elements used in u-h-f-equipment.

A standard plug-in silicon crystal is used as the detector, followed by a three-stage audio amplifier. The band width of the amplifier is 50 kc to permit visual beat indication even if the signal under measurement is unstable.

For very strong signals beat indication may be obtained either aurally from the built-in dynamic loud speaker or visually from the panel meter. For weak signals a telephone jack is provided for headset detection.

Normally no direct connection to the signal under measurement is required, the retractable 'antenna' providing the necessary coupling. On weak signals, terminals are provided for additional pick-up if necessary.

This instrument is finding wide application both in the laboratory and in the field where a portable, self-contained, stable and accurate heterodyne frequency meter is needed for measurements over a very wide range of high and ultra-high frequencies.

TYPE 720-A HETERODYNE FREQUENCY METER $340

SPECIFICATIONS

FREQUENCY RANGE — fundamental range of instrument is 100 to 200 Mc; by harmonic methods measurement range is 10 Mc to 3,000 Mc.

CIRCUIT — our butterfly tuning unit used in the oscillator; crystal detector (with spare); 3-stage audio-frequency amplifier.

BEAT INDICATORS — built-in dynamic loud speaker and panel meter for aural and visual beat indication; telephone jack for headset indication from weak signals.

ACCURACY — over-all accuracy is $\pm$ 0.1%

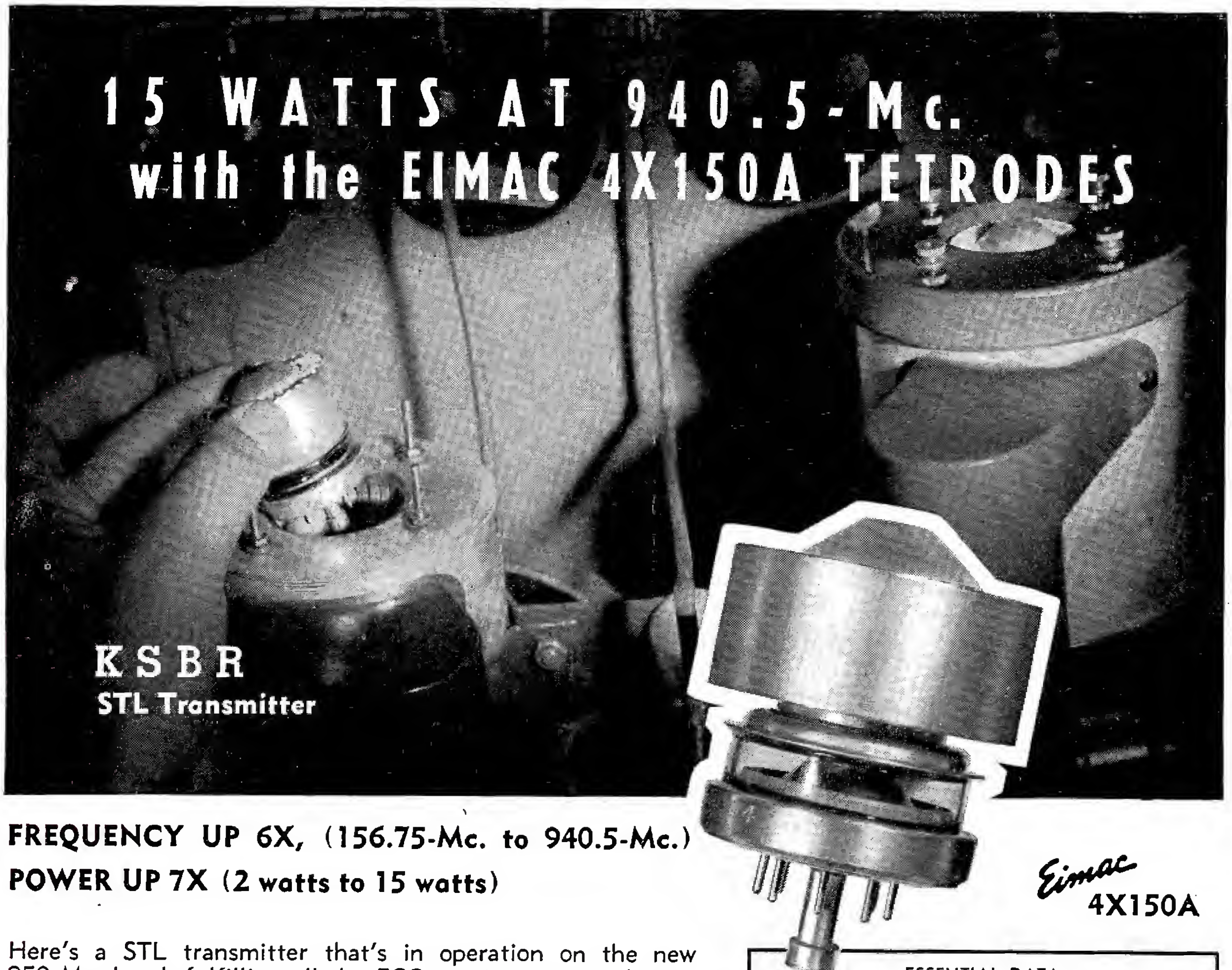
CALIBRATION — main dial calibrated in frequency, each division being 1 Mc; one-half turn of vernier dial corresponds to approximately 1% change in frequency over entire tuning range.

PORTABILITY — instrument weighs only 27½ pounds complete with batteries. Separate a-c power supply may be ordered for a-c operation.

GENERAL RADIO COMPANY Cambridge 39, Massachusetts

90 West St., New York 6 | 920 S. Michigan Ave., Chicago 5 | 950 N. Highland Ave., Los Angeles 38

15 WATTS AT 940.5-Mc. with the EIMAC 4X150A TETRODES



FREQUENCY UP 6X, (156.75-Mc. to 940.5-Mc.)
POWER UP 7X (2 watts to 15 watts)

Eimac
4X150A

Here's a STL transmitter that's in operation on the new 950-Mc. band, fulfilling all the FCC requirements and powered by Eimac 4X150A tetrodes. It's a part of the studio-transmitter-link between the San Bruno studios and the 250 Kw FM transmitter of station KSBR high atop 3849-foot Mt. Diablo some 33 miles away.

REL MODULATOR → 2 WATTS 156.75-Mc. → EIMAC 4X150A TRIPLER → 15 WATTS 470.25-Mc. → EIMAC 4X150A DOUBLER → 15 WATTS 940.5-Mc.

The R-F amplifier was specifically designed for the KSBR application by Eimac engineers. It is driven by an REL modulator delivering 2 watts output at 156.7-Mc. to one Eimac 4X150A in a tripler stage, which in turn drives a single 4X150A in a doubler stage, providing 15 watts useful output at 940.5-Mc.

The Eimac 4X150A is ideally suited for this application because of its high power gain at relatively low plate voltages, ability as a frequency multiplier without loss of amplification, low grid drive requirements, and a high ratio of transconductance to capacitance. It also has the advantage of being physically small and functionally designed for simple installation.

Complete data on the Eimac 4X150A for STL and other UHF applications is available by writing direct.

EITEL-McCULLOUGH, INC.
197 San Mateo Avenue, San Bruno, California

EXPORT AGENTS: Frazar & Hansen—301 Clay St.—San Francisco, Calif.

ESSENTIAL DATA
KSBR STL TRANSMITTER

REL MODULATOR, MODEL 694
EIMAC 4X150A, R-F AMPLIFIER

Useful Output Power	15 watts
Frequency	940.5 Mc.
Frequency Stability	.002%
Audio Frequency Response. Substantially flat	50 to 15,000 cycles
Distortion	.5% Max.
Noise Level - 70 db below 100% modulation	± 100 Kc. deviation

Eimac 4X150A
General Characteristics

Heater voltage	6.0 volts
Heater current	2.8 amps.
Minimum heating time	30 secs.
Grid Screen amplification factor	4.5
Direct interelectrode capacitance (Average)	
Grid-Plate	0.02 μμf
Input	14.1 μμf
Output	4.7 μμf

Maximum Ratings

D-C Plate voltage	1000 volts
D-C Plate current	250 ma.
Plate dissipation	150 watts
D-C Screen voltage	300 volts

Follow the Leaders to
Eimac TUBES
The Power for R-F